

# new scientist

18 September 1975  
Vol 67 No 967  
Weekly 25p

Australia 60 cents/  
Canada \$1.00/  
New Zealand 60 cents/  
South Africa 60 cents/  
USA (by air) \$1.60/  
FF 5,200/DM 3.00/  
skr 5.80/Spain 40 cts

## The carbide key to better jet engines



## BRINGING BRITAIN'S GAS TO YOU



## Buried Treasure!

The massive programme to increase Britain's supplies of natural gas is now well under way. The first stage of the long underground journey across Britain, which natural gas from the North Sea Frigg field will make to reach our customers, is a 170 mile stretch from St. Fergus in north-east Scotland to Bathgate, between Glasgow and Edinburgh. This section of 36 inch high pressure pipeline will involve the crossing of 409 roads, 41 rivers and 13 railways. It's a big job bringing natural gas to Britain. But it's worth it, because natural gas is Britain's most precious natural asset. North Sea oil is a promise for the future, but natural gas is *now* supplying 30 per

cent of the nation's useful heat. And by 1980 this could rise to 40 per cent.

Natural gas is good news for Britain. Because:

1. It is British\* - an indigenous fuel under our own control.
2. It is saving one thousand million pounds a year on our balance of payments and makes us less dependent on imported oil.
3. It is a pure form of energy which does not harm the environment.
4. It is highly efficient - it comes direct to the customer with virtually no waste.

\*And gas from the Norwegian part of the Frigg field will also be coming to Britain.

NATURAL GAS-TOO GOOD TO WASTE



**BRITISH GAS**  
Our Vital Industry



Editor: Dr Bernard Dixon  
Deputy Editor (Science): Dr Peter Stubbs  
Deputy Editor (Technology): Nicholas Valéry  
Managing Editor: Richard Fifield

Science Policy Editor: Dr Martin Sherwood  
Science Editor: Dr Roger Lewin  
Assistant Science Editor: Dr Robert Weigete  
Social Editor: Ian Low  
Technology Editor: Michael Kenward  
Technology Policy Editor: Dr Joseph Hanlon  
Technology News Editor: Lawrence McGlin

Art Editor: Tom Reynolds  
Assistant Art Editor: Chris Jones  
Artists: Neil Hyslop, Michael Peyton

US Editor: Grehem Chedd  
72 Addington Rd, Brookline,  
Massachusetts 02146

Consultants  
Biochemistry: Dr Robert Freedmen  
Computers: Hadley Voysey  
Developmental biology:  
Dr Bridgid Hogan  
Education: John Delin  
Environment: Jon Tinker  
Marine: Tony Loftas  
Psychology: Dr Nick Humphrey  
Soviet Science: Dr Sarah White

Advertisement manager: Roy Edwards  
Advertisement production: Enid Broderick

Advisory Panel  
Sir Monty Finniston FRS  
Sir Willem Glenville FRS  
Dr Basil Meson FRS  
Professor Sir Michael Swann FRS

Monitor	630
Technology review	647
Energy file	654
Feedback	658
Westminster scene	665
New York view	665
EEC notebook	666
Perspective	667
Pig-ignorant	667
Venture	668
A grounding's notebook	668
The last word	669
Tantalizer	669
Letters	674
Grimbledon Down	674
Ariadne	688

---

**Comment** Professor Steven Rose, John Delin, Robert Waller 626

---

**The ceramic engine prepares for take off** Nicholas Valéry 634

---

**Shock-absorbing biopolymers** Dr David Hukins 636

---

**Fisheries need managers, not owners** Tony Loftas 639

---

**Setting fire to damp brains** Dr Peter Baker 641

---

**New blocks for the computer builder** Professor David Aspinall 643

---

**John Stuart Mill and the no-growth economy** Dr John Loraine 660

---

**The structure of glucagon** Dr Tom Blundell 662

---

**Review** Professor Cyril Darlington FRS, Dr John Humphrey FRS,  
Dr Martin Sherwood, Dr Colin Roberts, Michael Kenward,  
Dr John B. Free, Professor Robert Weale, et al 670

---

## PUBLISHED WEEKLY

Publisher's subscription rate, inland: £15.10  
Overseas surface mail: £18.40  
USA and Canada (airfreight) \$44.30  
Back numbers (each with order) 50p  
Including postage from IPC Magazines Ltd,  
66-68 Great Queen Street, London WC2E 8DD  
Registered at The Post Office as a newspaper  
and printed in England  
2nd class postage paid at Jamaica NY, 11431  
Airfreight and mailing in the USA by  
Publications Expediting Inc., 200 Meacham  
Avenue, Elmont, NY 11003  
© IPC Magazines Ltd, 1975

## OVERSEAS ADVERTISEMENTS REPRESENTATIVES

USA: Jobson, Jordan, Harrison & Schulz Inc., 57 Post Street, Suite 712-715, San Francisco, California 94104  
(415) 392-6794, and 1901 West Eighth Street, Los Angeles, California 90057 (213) 483-8530  
East Coast and Mid West,  
William F. Strube & Associates Inc. 230 Park Avenue, New York, NY 10017 (212) 686-7642

CANADA: Clement Dick, Chimney Copse, RR No 1, Churchill, Ontario, Canada. (705) 456 2341

JAPAN: International Media Representative Ltd, 1, Shiba-Kotohira, Minetoku,  
Tokyo, Japan. Tel: 502-0656, Telex: 22633

EUROPE: Advertisement Department, New Science Publications, 128 Long Acre, London WC2E 9QH.  
Tel: 01-836 2468. Telex: 27253. Cables: Newscient London WC2

# Comment

## (N)euro-politics

At a time when the launching of new journals must be hazardous and when *Brain Research* is already printing several hundred pages fortnightly, at least four new journals with titles permuting the words "neuro-science", "research", and/or "international" have been published this year, as well as several dozen volumes of conference proceedings and the forerunners of annual "Progress in..." review series. It is not clear when any of these journals and books will be read, even assuming that there are universities or institutes with budgets available to buy them, because a significant proportion of the world's neurobiologists have spent the period since July in almost continuous transit to and from an increasing round of national and international meetings in choice conference centres, from Amsterdam to Jerusalem, from Munich to Madrid. Not that the round is yet over; this week sees a neurobiology meeting in Göttingen (the second there this summer), and for those in Britain not yet satiated (and with funds still to spare), the Brain Research Association has a school in Cambridge starting on 22 September while the Institute of Biology holds a symposium on the visual system a few days later in London.

It is against this background that we must judge what seems to be a developing trend, so far as Europe is concerned: the establishment of supranational learned societies and organisations. Where hitherto there have been national societies and periodic international meetings (of biochemistry, physiology, psychology, etc), moves are afoot now to create all-European societies, following the example of the well established Federation of European Biochemical Societies (FEBS), the European Brain and Behaviour Society, and EMBO. There are plans for a European Society for Neurochemistry. And a five day meeting at Munich last week inaugurated a proposed new European Neuroscience Society (ENS).

The emergence of ENS is an interesting example of the new Euro-politics, as it appears to have been set up on the initiative of an organisation called the European Training Programme in Brain and Behaviour (ETP) which, funded initially from West Germany with participation from other Common Market countries as well, has for some years now been sponsoring exchanges of personnel and information between neuroscience laboratories. An ETP committee planned the Munich meeting and sent out a "call for

papers" at the end of 1974; there were nearly 500 responses, and in the event well over that number attended the Munich meeting, one of whose sessions was devoted to a discussion of whether there should be future meetings of the same type and whether there should be a European Neurosciences Society. No prizes for guessing the conclusion, nor that a continuing committee was established to carry the work forward.

Yet here is where the issue runs heavily into politics. How should such a committee, or the ENS itself, be constituted? The directorate of the ETP is appointed "from the top down", and is scarcely either nationally or scientifically representative. In fact, the "Europe" of the Munich meeting turned out to be at best only half of Europe; the Eastern European, Comecon countries, were conspicuously absent. If scientists from these countries are to participate, an effort must be made to develop a structure which the bureaucracies of state capitalist scientific management, as well as the slightly more entrepreneurial style of Western capitalism, can handle—that is, a federal structure with some sort of national representation (like FEBS itself). And if such societies as ENS are ever to have a semblance of democracy, their controlling committees must contain scientists who have some sort of national constituency—for example, the Brain Research Association in Britain—rather than be "Eurocrats" appointed by a process as obscure as that of a Brussels EEC Commissioner. If this were not complex enough, in a hybrid field like the neurosciences there also has to be some sort of balance in committee between neurochemistry, psychology and the other component disciplines.

Can any viable structure meet these criteria? For many of those who attend such meetings, it may be a matter of relative indifference, provided the conference halls are good; the hotels not too expensive; and the entertainments, put on by the local organising committee and paid for out of registration fees, donations from drug companies and city councils, are lavish enough. Yet the management of scientific societies has become, if not big, then substantial business. National scientific learned societies have, on the whole, a fairly democratic and representative tradition. It would be a pity if, at the international level, a sort of corporate, non-representative European institutionalism were to take control.

Steven Rose

## New foundations

Educational egalitarianism in Britain takes a further step forward today (18 September) with the publication of a report on examinations at 16 plus by a working party of the Schools Council. The principal proposal is that in each subject a single examination should cover both GCE and CSE certificates. To be known as "The Certificate of Education: Foundation", it would be marked in seven grades—1A, 1B and 1C representing grades A, B and C at GCE O-level, and grades 2-5 representing CSE grades at these levels. Candidates not reaching grade 5 would be described as unclassified and the subject would not be entered on their certificates. Three modes of examination with variations are envisaged, from external examinations of the existing variety to externally supervised "in house" schemes which would be devised and examined within the

schools.

The new proposals result from several years' collaboration between GCE and CSE examining boards and experimental trials to assess the possibilities of a common system in addition to a number of research projects on the whole question of public examinations in schools. A total of 62 joint examinations were held in 1973 and 1974, with over 65,000 candidates and 17 subjects ranging from English, mathematics and biology to technical drawing, needlework and woodwork. The working party recommends that the new examination should be controlled by teachers and reports considerable support for the idea from teachers who took part. Simplified administration, improved morale among pupils, and (in particular), not having to decide far in advance which

examination should be taken, are among the advantages quoted.

The final detail may somewhat mitigate enthusiasm. For example, collaboration between the Cambridge Local Syndicate (GCE) and the East Anglian Examinations Board (CES) produced a two paper mathematics examination taken by nearly 2900 candidates over the two years. In the first paper, consisting of 36 short answer questions, candidates answered most questions, although reservations were expressed about the least able. The second paper, consisting of 15 structured questions, was meant to be more difficult and "a large number" of less able candidates achieved very little. The spread of marks was described as reasonable although there were very few high marks and in 1973 more than a quarter of the candidates achieved less than 15 per cent of the marks. In 1974 the position was somewhat improved, although it remained less than satisfactory. The "lower boundary" for CSE grade 5 (the point below which no certificate is granted) was 9½ per cent.

Not surprisingly, the Cambridge people saw a need for a common system rather than a common examination. The East Anglians saw no problems which could not be dealt with in accordance with their normal procedures; a majority of the participating schools felt the advantages outweighed the disadvantages.

Admittedly, experience among the 23 groups of examining boards involved varied considerably. Yet certain themes persist. The problems of the less able was a perennial, variation in standards and the question of standardisation worried some boards. The Schools Council itself has yet to pronounce on its working party's proposals but one possible outcome could be the common system idea coupled with graded alternative papers, particularly in strongly structured subjects such as mathematics and physics. More able pupils might well consider ploughing through what they regard as trivial as nothing more than a chore. But would the less able genuinely regard a certificate based on questions they barely understood as a record of achievement? *John Delin*

## Plea for rural medicine

Beginning on Sunday (21 September), the International Association of Agricultural Medicine and Rural Health is to hold an important congress at Churchill College, Cambridge\*. It will be particularly concerned with the effects of rapid changes in agriculture on health. While occupational medicine serves workers in the controlled environment of the factory, there is no comparable service for workers in the fields. The president of the association, Dr Charles Elliot of Wisbech, has been drawing attention for many years now to the lack of a rural medical service in Britain to bring together the doctor, the district nurse, the veterinary service and the hospital laboratory service. Rural medicine, he also contends, should be part of postgraduate teaching.

The typical British farm is a small family concern, which thus suffers severely when any of its working members are disabled. The fatal accident rate in agriculture of 16.5 per 100 000 is second only to that in the construction industry (19.3). It can be a hard task to persuade the stoical countryman to visit the doctor, so he often suffers unnecessarily from the effects of constant exposure to the weather. But in addition to that, many unexpected ills, varying from rodent ulcers in Norfolk smallholders to frostbite among Bedfordshire brussel-sprout pickers, keep country doctors vigilant for causes of ill-health that have not yet been documented.

Rapid changes in agriculture bring with them both physical and psychological dangers. Economic pressures, for example, are leading to disorders such as cardiovascular diseases that are more usually associated with urban businessmen. The tractor driver now bumps for hour after hour up and down the prairie sized fields of our arable farms, with his spine twisted and rotating as he looks over his shoulder to monitor or alter the implement he is pulling. Without the company of fellow workers, he may wonder if he is not worse off than a machine operator in a factory, despite his apparently healthier life in the open air. The old farm worker walked behind the plough and had the company of the horse. The Back Pain Association estimates that back pain is responsible for between 13 and 15 million lost working days per year in Britain; agriculture must account for a considerable proportion of these. And a recent investigation of a sample of tractor drivers working in Bedfordshire showed that half were suffering from noise induced deafness. Many

tractor drivers now have to wear ear plugs. Dr Elliot considers that a revolutionary redesign of the tractor is required so that it can fulfil its function without causing so much trauma.

Rural medicine should not, however, be regarded as merely a concern of the countryside. Diseases originating on the land can spread across the whole of society, as the Black Death, caused by the bacillus *Pasteurella pestis*, transmitted from infected rats by means of fleas, warned mankind. Over 100 zoonoses (diseases carried by animals to man) are now recognised. And with the discovery of transferable resistance to antibiotics among bacteria carried in the guts of both man and farm animals, the dangers of untreatable disease in a community, arising in farming practice, have become more apparent (*New Scientist*, vol 36, p 33). Professor E. S. Anderson FRS of The Enteric Reference Laboratory, Colindale, has constantly highlighted this danger in countries using intensive methods of animal husbandry but without regulations restricting the use of antibiotics in agriculture. Two particular dangers are the proliferation in livestock of drug-resistant pathogens, such as *Salmonella typhimurium*, which are then conveyed to farm workers; and, secondly, the transfer of antibiotic resistance from harmless bacteria living in the animal gut to those capable of causing human disease.

Rural medicine is thus an important arm of preventive medicine, both economically and hygienically. The Churchill congress is of world wide significance, especially at a time when modern agriculture is just being established in many parts of the world. In Britain, there are hopes that the Association for Rural Medicine, which is allied to the International Association of Agricultural Medicine and Rural Health, may come to play a more active role in promoting health and safety on the land. Dr Elliot foresees the possible establishment of some form of health service for agricultural workers, based on the principles of preventive medicine. Such an innovation is badly needed—not least because, in contrast to the health education and safety exhortations so strenuously aimed at the factory worker—little is done at present to bring these matters to the attention of people employed on the land

*Robert Waller*

\* Further details may be obtained from T. L. Bourke, Highway Lodge, Brighton Road, Tadworth, Surrey.



# Programmable calculator

## NEW! Sinclair Scientific Pro

Three or four years ago, personal scientific calculators revolutionised the work of scientists, engineers and mathematicians.

With a wide variety of pre-programmed functions—logs, trig,  $\sqrt{x}$ ,  $x^2$  and many more complex functions—they took a lot of the drudgery out of calculations.

They were expensive.

But they were infinitely faster and normally more accurate than slide rules or tables.

### Programmable calculators—unlimited power

Personal scientific calculators had limitations: the number of functions was determined by the number of keys that could be crammed onto a keyboard; and every extra function meant extra cost.

Programmability overcomes both limitations—and makes a calculator vastly more powerful. With a programmable calculator, the number of functions which can be performed is unlimited.

It becomes a true miniature computer.

**The Sinclair Scientific Programmable: fastest, cheapest, most convenient**  
The two or three personal scientific programmable calculators on the market so far have cost hundreds of pounds.

The Sinclair Scientific Programmable is a technological breakthrough.

As a straightforward scientific calculator,

it's remarkable. It gives access to the full range of scientific and mathematical functions. It uses true scientific notation. And it's the fastest personal scientific machine on the market—all functions are to all intents and purposes instantaneous.

It has an exceptionally convenient 19-key keyboard.

It's completely self-contained—even program-entry takes place through the keyboard.

And it costs only £29.95!



### Functions and features of the Sinclair Scientific Programmable

#### Keyboard-entry programmability

Programs up to 24 steps entered simply by keying in a sequence equivalent to calculation. No program takes longer than 30 seconds to enter.

#### Scientific notation

Full scientific notation, with floating-point entry option. Post-fixed operators (reverse Polish) for convenience in handling complex calculations. Exponent range:  $10^{-99}$  to  $10^{99}$ .

#### Log and trig functions

Sin, cos, arctan (radians);  $\log_{10}$ , antilog $_{10}$ ;

other functions immediately derivable.

#### Mathematical functions

$+$ ,  $-$ ,  $\times$ ,  $\div$

$\sqrt{x}$ ,  $\frac{1}{x}$ ,  $x^2$ , sign change.

#### Three-function memory

Store, recall, exchange.

Program store can be used to give up to three extra memories.

#### Large green display

Mains/battery option

#### Program library

Over 400 standard programs.

#### One-year, no-quibble guarantee

#### Size

156 mm  $\times$  77 mm  $\times$  33 mm. Weight: 200 g.

### Sinclair Scientific Programmable—a personal computer for under £30

The Sinclair Scientific Programmable is startlingly good value.

It represents a tremendous design achievement: all the functions of the calculator are packed onto a single chip—an outstanding example of large-scale integration.

Other calculators use up to five or more chips—expensive to produce, and expensive to assemble.

The unique single Sinclair chip means that the Scientific Programmable—the fastest personal scientific calculator in the world—can be sold for £29.95 including VAT.

## 10-day no-ob

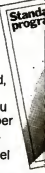
There's a lot more to this remarkable machine—far more than one advertisement can describe.

You need to see it and handle it...to program it yourself in a few seconds to save you hours...to check its performance against tables and graphs...to see the full range of standard programs.

It's not everybody's calculator—and as yet, it's not in the shops.

So we're offering you a 10-day trial. Use the order form and send us a cheque or your Access, Barclaycard, or American Express number. We'll send you a calculator direct. Or if you prefer, phone your credit card number to Ann Dent on St Ives (0480) 64646.

Use it for 10 days—and if you don't feel it's £29.95 well spent, send it back.



# -dramatic breakthrough! programmable. For under £30!

## Programmability—what it is... what it offers

Any calculation consists of a series of operations performed on constant or variable numbers.

With a non-programmable calculator, every step demands at least one key-stroke.

With a programmable calculator, constants and operations can be stored in the right sequence in the calculator, ready to operate on the variables as they are entered. (The calculator becomes a miniature computer.)

The task of the operator is reduced to entering the appropriate variables at the appropriate points.

Programs may be taken from the program library or devised by the operator. Either way, they are entered simply by keying in a sequence equivalent to the calculation.

This means

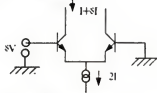
1. *unlimited power*—any function can be entered as a program;
2. *enormous time-saving*—for repetitive or iterative calculations only the variables need be entered;
3. *consistent accuracy*—eliminates risk of operator error during program execution;
4. *flexibility*. The Sinclair Scientific Programmable offers the choice of mains or battery operation—once programmed can even be given to an operator who does not understand the program.

## How the Scientific Programmable saves you time

This is most evident in repetitive calculations and in iterative procedures like the Newton-Raphson method of successive approximation.

### Typical examples of repetitive calculations

1. An electronics engineer needs to plot the theoretical output waveform of a long tailed pair with current source tail for a sine wave input of peak value  $V_{pk}$ .



The change of output current is described by the formula:

$$\frac{\Delta i}{I} = \frac{SV}{(I(60+1))} \text{ where } SV \text{ is in mV}$$

By storing a 24-step program, from the program library, he can rapidly construct a plot of the output waveform by entering  $V_{pk}$  in mV plus a series of linear steps corresponding to the time axis of the graph.

With no further instructions, the machine calculates the sinusoidal input waveform, applies it to the transfer function given, and displays the normalised change in output current.

If the calculation had to be performed step by step each time, graphing any substantial number of values could take hours. With the Scientific Programmable, each plot is instantaneous.

2. An accountant raising a loan may have a number of quotations giving different repayment terms and interest rates. He can enter a standard program from the program library to calculate annual repayments for any number of combinations in a matter of minutes.

### Typical example of iterative process

Solve the equation  $\tan x = 1 + x$ .

By storing as a program the formula for solution by successive approximation, the solution can be obtained with high accuracy in a matter of seconds.

### Over 400 standard programs

The procedures above are derived from some of over 400 standard programs in the Sinclair program library. Other programs include:

#### General

Fahrenheit to centigrade and centigrade to Fahrenheit conversion  
Degrees minutes and seconds conversion to radians

#### Finance

Compound interest  
Loan repayment  
Cashflow

#### Electrical and electronic engineering

Field variation from aerials  
Reactance frequency chart  
Transistor noise minimisation  
Determination of values for ladder attenuators

#### Statistics

Sample mean

#### Geometry

Area of a triangle  
Surface area of a cone

#### Mathematics

Equation solving  
Hyperbolic functions of polynomials  
Roots of quadratic equations (real and imaginary parts)

Decimal to binary and binary to decimal conversion

Resolution of forces via parallelogram law

Beam deflection analysis  
Critical loading of struts

Equations of inertia of square section toroids  
Thermodynamics

Heat conduction shape factor of a cylinder  
Fluid mechanics

Flow rate in a venturi  
Materials

Determination of crystal spacing from X-ray diffraction data

## gation offer.

We'll refund your money without question.

There's nothing to lose, and so much calculating time to save. Post the coupon today.



Sinclair Radionics Ltd,  
London Road, St Ives, Huntingdon,  
Cambs., PE17 4HJ.  
Tel: St Ives (0480) 64646.

**sinclair**

VAT Registration No 213 8170 88.  
Registration No 699483.

Operating instructions



To: Sinclair Radionics Ltd, St Ives, Huntingdon, Cambs., PE17 4HJ.

Please send me .....(qty) Sinclair Scientific Programmable calculators, at the introductory price of £29.95 each (to include calculator, carrying case, battery, mains adaptor, full instructions, program library, VAT, postage and packing—no more to pay).

I understand that if I return the calculator and accessories within 10 days from receipt you will refund my money in full.

Name (please print) \_\_\_\_\_

Address \_\_\_\_\_

\* I enclose cheque no.....for £.....

\* Please debit £.....to my \*Access/Barclaycard/American Express account number .....

\* Please complete as applicable

This One



TYD7-E5G-2GYD

# Monitor

## Pinning down the solar-terrestrial weather link

The reality of the link between specific solar events and changes in weather patterns on Earth now seems to be established. In last week's issue of *Nature* (vol 257, p 113) Dr Robert Olsen, of the University of Colorado, Dr Walter Roberts of the University Corporation for Atmospheric Research, and Dr C. S. Derefos, of the National Center for Atmospheric Research (all in Boulder, Colorado) have gone some way towards spelling out details of the mechanism involved. Roberts in particular has been involved in this story for many years, starting from the observation that there seemed to be a tendency for troughs of low pressure at high latitudes to be deeper a few days after bright aurorae. Since the aurorae are caused by bursts of solar particles, Roberts has long argued that these solar events affect the weather—but it has taken time to build up a statistically reliable picture of what is going on.

The latest step combines observations of solar flares, geomagnetic storms on Earth, and tropospheric vorticity. A basic pattern emerges in which the vorticity area index (VAI) at the 500-millibar level in the atmosphere (a rough measure of the strength of cyclonic activity over the northern hemisphere) responds to solar flares in two ways. First, there is an increase in the VAI during the first two days after a flare, then there is a geomagnetic storm followed by a sharp decrease in the VAI. This picture at once confirms and partially quantifies the earlier studies.

It takes about six days for the pattern of events to be completed. By day one or two after the flare the VAI has increased by 5 to 10 per cent above the background; by day two or three the geomagnetic storm has started; by day three or four the VAI decreases by 5 to 10 per cent below the background (10 to 20 per cent below the post-flare

maximum); and by day five or six things are back to normal. The deepening of Pacific troughs, found in the earlier studies to occur about three days after bright aurorae, fits this pattern nicely, and there is little room for further doubt concerning the reality of this solar-terrestrial link.

In the conclusion of their *Nature* paper, the Boulder team plead for observations which will give a clue to what factor in solar activity is most important. They particularly request information on the position on the solar disc of the relevant flares. By a happy coincidence that information is available in a letter from Dr J. T. Horng, of the Telecommunications Laboratory in Taiwan, just published in *Astrophysics and Space Science* (vol 35, p 133). From a study of geomagnetic events and solar activity over 1968 to 1972, Horng concludes that the terrestrial effects are caused by spot groups between 6-7° and 19-9° E of the solar meridian. It remains to be seen just how Olsen and his colleagues will interpret this new discovery, but clearly the pieces of the puzzle are beginning to fall into place.

## Astronomers eye the virgin nova

The nova that burst forth in the constellation Cygnus three weeks ago is certainly most unusual. The maximum brightness it reached was 1.5 magnitudes, after which it suffered decline, becoming 6 mag (invisible to the eye) on 8 September. No object is visible on the Palomar Sky Survey at the position of Nova Cygni which implies a prenova star fainter than 21 mag. Therefore the total amplitude of the light curve is at least 19 mag. That is considerably larger than the average for a nova, and for a time observers speculated that they might have a supernova in view. Nova CP Puppis 1942 managed a rise of at least 16.5 mag. Both that burst and Nova Cygni appear to be of virgin novae erupting for the first time. On the magnitude scale used in astronomy 5 mag corresponds to a change of 100 in energy and 19 mag to an increase of 40 million times.

The spectrum reproduced here was obtained at the Cambridge Observatories by Noel Argue and Mark Rayne on 3 September. Very intense and broad emission lines of hydrogen are present. For comparison we also show a normal (type B5) star, in which the lines are sharp absorption features.

Professional observatories throughout the northern hemisphere have this nova under constant scrutiny. As well as hydrogen emission the spectrum has contributions from oxygen, calcium, silicon, and iron. The displacements in the wavelengths indicate

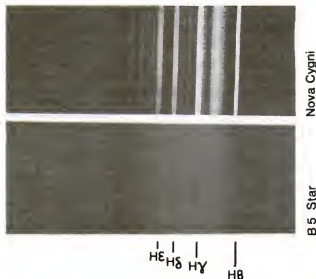
that matter has been expelled at velocities that accelerated from 1500 km/s at the start of the burst, to 3000 km/s a few days later. Such speeds are practically unprecedented for novae.

From the exceptionally fast decay it appears that the nova's maximum absolute brightness was -9.5 mag. Comparing this with the apparent brightness yields a distance of 5000 light years.

The X-ray astronomy group at Leicester University reports that the nova is not detectable with the Ariel 5 satellite. That means that the ratio of X-ray to optical luminosity is at least

30 million times less than for A0620-00 the brilliant X-ray nova that flared last month. Observations with the 5-km radio telescope at Cambridge have given a null reading too. Both of these results have been confirmed elsewhere.

There are probably 50 to 100 novae per year in our Galaxy. Only a handful are observable, even with the largest telescopes. Explosions as powerful as Nova Cygni are rare. The nova phenomenon occurs in binary star systems: at a late stage of stellar evolution one star expands until it spills matter onto its companion and triggers an explosion. The details of the process are still obscure, but Nova Cygni may stimulate a new effort to understand these stars.





## The sceptics hit out at monopole claim

The so-called magnetic monopole whose discovery was reported last month (*New Scientist*, vol 67, p 412) may be nothing but an ordinary platinum nucleus. And Professor P. Buford Price of the University of California at Berkeley, who headed the team which discovered the "monopole", is now coming under severe criticism.

In his paper in *Physical Review Letters* (vol 35, p 489), Price was forced to say, "...independent of all details of calibration of response of the Lexan..." (the polycarbonate primary detector) because he had not done a detailed calibration, according to Professor Peter Fowler of Bristol University, another cosmic-ray expert. Fowler said Lexan's properties are not reliable, and one paper was, reportedly, withdrawn from the recent Munich Cosmic Ray Conference because of just this calibration problem. Price went ahead, nevertheless, and now that he has done the calibration, has had to modify the data already published.

In practice, the calibration error does not affect the argument. But some physicists view it as showing an undue rush for publication and publicity. Price, who just a month ago happily posed for newspaper photographs and gave interviews, refuses to talk to the press now that his result has come into question.

The alternative explanation for the "monopole" comes independently from Fowler and Nobel Laureate Luis Alvarez, from Price's own department at Berkeley.

Price's balloon-borne cosmic-ray detector consisted of a Cerenkov detector and film, an emulsion, and a stack of 33 Lexan sheets. There is no mark on the Cerenkov film, which means that  $\beta$ , the speed of the particle as a fraction of the speed of light, must be less than 0.68. The emulsion shows that either the

charge of the particle,  $Z$ , must be around 80. Alternatively the particle must be a magnetic monopole. Price and his critics agree on this.

But they disagree on the way the Lexan has been used to distinguish between these two possibilities. As a particle passes through Lexan, its damage to the long-chain molecules is in direct proportion to  $Z^2/\beta^4$ . After an experiment, the Lexan sheets are etched in sodium hydroxide. The damaged portions are etched faster, resulting in cones where the particles enter and leave the sheets. Data are presented as the etch rate of the cone measured in micrometres/hour (see figure, from *Physical Review Letters*).

A nucleus will slow down in Lexan increasing the damage to the plate, and thus the etch rate, as it passes down the stack of sheets. The result is a line on the graph drifting to the right. A magnetic monopole should not slow down. The dotted line is Price's prediction of  $Z=96$ ,  $\beta=0.75$ . A collision with a carbon or hydrogen atom in the plastic followed by a loss of charge, however, would cause a sudden movement to the left.

The data clearly divide into two parts. Above a depth of 1.3 there is a sudden jump left, followed by the drift right expected of a slowing particle.

Reached by telephone at the National Center for Atmospheric Research field station for balloon flight, Palestine, Texas, Fowler explained his interpreta-

tion. A platinum-78 nucleus comes into the stack from above at just below the Cerenkov limit of  $\beta=0.68$ , precisely the non-monopole case permitted by the other two tests. Part way through it collides with an atom in the Lexan and loses two charges, probably as an alpha particle. This does not show on the graph because the charge loss counteracts the slowing down. Next, at about 1.3 units deep in the stack, it collides again, this time losing three charges—an alpha and a proton. This shows clearly on the figure.

How plausible is this version of the event? Fowler says that the stack has a thickness about half the mean free path for a nuclear collision, so that double collisions must be expected. He also says that a change of two charges should change the etch rate about 10 per cent, while Price's RMS error is about 6 per cent. Thus, although that much change should be seen, "it could be lost in measurement error".

In effect, Price must ignore the fluctuation in the bottom half as statistical error, while Fowler must blame the lack of fluctuation in the top half as statistical error.

Fowler argues that Price must have 10 to 20 tracks of slowing platinum, and that this is merely the "most extraordinary" one. "You must rule out nuclear collisions absolutely and completely before you entertain something exotic like a monopole," he declared.

## Drop dead! So they did—but how?

Rats can obstinately survive poisoned bait offered by humans, but may drop dead from a snub offered by other rats; and there is no complete explanation for either phenomenon. Anthony Barnett, who has been exploring the psyche of this foremost of man's furry enemies for more than 30 years, has made sporadic attacks on both questions. The latest report on poison-shyness ends, still, with a shrug of the shoulders. But a little light is now emerging from the fog of mystery surrounding the so-called social stress syndrome.

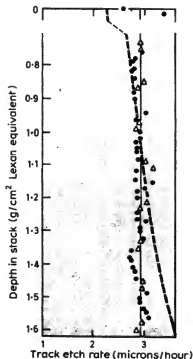
One of the first points to emerge when Barnett began to look into the responses of rats to poisoned bait was simply that wild rats automatically avoid anything new. The simple solution to that was to leave the bait around unpoisoned for a few days until they got used to it. But it turned out that, even then, they generally took only a nibble of the poison and never went near the bait again. What is more, checks in the laboratory show that they can actually distinguish poisoned from unpoisoned food, at least in some cases. Attempts to find out how they do it, however, have so far succeeded only in showing how they do not do it.

With colleagues at the Australian National University, and an Indian collaborator whose interest in poisoning pests is more than academic, Barnett investigated the effects of offering rats a choice between millet on its own and

millet laced with the poison zinc phosphide. The rats duly avoided the poisoned grain. Then the research team tried destroying the rats' sense of smell with zinc sulphate; they still avoided the poison—which leaves only the rather unhelpful conclusion (*Behavioural Biology*, vol 13, p 183) that, however they do it, it is not by smell.

Wild rats are pathetically susceptible to the hostility of other rats. A strange rat entering an established colony may be greeted with stereotyped threat displays from colony members which leave him physically unscathed but nonetheless kill him as surely as a jab in the jugular. The victim is physically normal on post-mortem. The only mark Barnett could find at first was a significant enlargement of the adrenal glands. That would not in itself cause death, but it is a clear index of stress.

Barnett and his colleagues (*Aggressive Behaviour*, vol 1, p 123) examined in detail the renal history of about 40 animals, 13 of which collapsed and died in the course of the experiment. They also examined the kidneys of a healthy control group. No trace of disease could be found in any of the controls, but the majority (about 90 per cent) of the stressed rats showed abnormalities of the kidneys. Since the kidney pathology alone could not have been fatal, it seems that the total picture will turn out to be complicated.



## Soviets get their teeth into carbon sandwiches

By forming "sandwiches" of complexed metal ions between the layers of carbon atoms in graphite, which are arranged in regular hexagonal networks, a team of Soviet scientists has produced a new class of compounds which promise a range of compounds which promise a new class of catalysts. In graphite the carbon layers are loosely held together at a distance of about 3.35 angstroms. Because of this large gap, and the weak bonding between the layers, a wide variety of atoms or molecules of other substances can be trapped in the interlayer space. These so-called "lamellar" compounds of graphite have been recognised for many years.

### Guests in graphite

Among the "guest" substances are alkali or alkaline earth metal atoms, halogens, and halides or oxides of metals. The bonding between

the guest and host lattice is usually weak and of the Van der Waals or charge-transfer type.

The hexagonal rings of carbon atoms in each layer are somewhat reminiscent of aromatic molecules. Since certain aromatic molecules can act as ligands in organometallic complexes with Group VI metals (chromium, molybdenum, or tungsten), if we think of the graphite as an infinite aromatic molecule, then we might expect similar strongly-bonded complexes to form from transition metals and graphite.

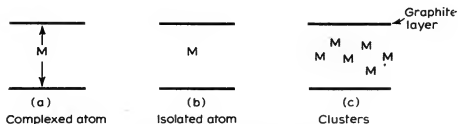
In the *Journal of the American Chemical Society* (vol 97, p 3366) M. E. Vol'pin and nine co-workers from the Institute of Organoelement Compounds and Chemical Physics in Moscow, report the synthesis of lamellar compounds containing different trans-

ition metals—some of which have very unusual properties.

Trying to establish the structure of these compounds is fairly difficult since the metal atoms can be complexed (A) isolated (B) or clustered (C). Vol'pin used a combination of X-ray diffraction, Mössbauer spectroscopy, magnetic, and chemical data to show that iron, cobalt and nickel form weak complexes, but that molybdenum forms a very strong complex. The molybdenum complex is very similar to the common bis (arene) complexes (or sandwich compounds, *New Scientist*, vol 59, p 64), and indicates that the graphite does act as an aromatic  $\pi$ -bonding ligand.

### Some applications

The structures of these new compounds are such that they may have industrial applications as catalysts: the metal atoms are free or only weakly held; the graphite layers are highly conducting and can allow electron transfer reactions to occur; and, with layers a fixed distance apart, good selectivity is possible. One of the applications the Soviet group tried out is the dehydrogenation of formic acid and simple alcohols. The lamellar nickel compound proved to be an effective catalyst for converting formic acid to carbon dioxide and hydrogen, ethanol to acetaldehyde, iso-propanol to acetone, and cyclohexanol to cyclohexanone.



Ways in which the metal atoms can be complexed in the carbon sandwiches

## Unsaturated fats in infants inhibit drug metabolism

In newborn rats (and humans) the enzyme system in the liver responsible for metabolising and inactivating drugs and other foreign compounds is quite inactive. (This system is also involved in the degradation of haem, so that its low activity in the newborn often leads to jaundice). The low activity is puzzling in some ways, because the actual components of the system are present even in the foetus.

Several people have proposed reasons for this low activity, but none has been as simple as that now offered by Michael Iba, Lester Soyka and Martin Schulman of the University of Illinois College of Medicine (*Biochemical and Biophysical Research Communications*, vol 65, p 870).

The enzyme system is bound to the membranes known as microsomes in liver cell homogenates, and Iba and his colleagues provide evidence that the lipid components of these membranes are actually inhibitory to the enzyme system. Their experiments involved extraction of lipids from liver microsomal membranes of newborn and adult male rats, and adding these to intact microsomes from adults. All the lipid extracts inhibited the drug-metabolising enzymes, but the extracts from newborn rats were twice as effective as those extracts taken from adults.

Fractionation of the lipid extracts

showed that the inhibition was due to phospholipids alone, and that the phospholipids from newborn rats contained twice as many unsaturated bonds in the fatty acid side chains as did those from adults.

Treatments which destroyed the double bonds destroyed the inhibitory effect, so that Iba, Soyka and Schulman conclude that it is the phospholipids containing unsaturated fatty acids which are responsible for the inhibition. The high level of such phospholipids in the microsomes of newborn rats is therefore responsible (in part, at least) for the low level of drug metabolism in the newborn animal.

### Surface waves found in thin films

Guided surface waves have been revealed in thin graphite films. Two workers from Cornell University, using the technique of high angular resolution electron scattering, have observed peaks in the characteristic spectra of electron energy loss from thin graphite films and the peaks seem to correspond to surface waves.

At long wavelengths, in thin films with a dielectric constant greater than unity, the characteristic energy loss of an incident electron manifests itself in the

form of an electromagnetic wave. The wave propagates through the film as though it were acting as a waveguide. Such modes have previously been observed only in thick films and in this form are already in use in various optoelectronic devices.

The workers from Cornell—C. J. Chen and J. Silcox—performed their experiment using an electron microscope. They fired a 75-keV electron beam, with an angular spread of less than  $8 \times 10^{-4}$  radians, at  $60^\circ$  to the surface. Arranging an electron spectrometer with a resolution of 0.5 eV underneath the electron microscope they obtained a record on a photographic plate which, was in effect, a direct map of the scattered intensity as a function of the incident electron's energy loss and the scattering angle. Their results show that three surface modes are excited between 4 and 11 eV by electrons incident at the smallest scattering angles.

Chen and Silcox claim further support for the excitation of surface waves by studying films thinner than their original sample—which was 75 nm thick. In a 50-nm specimen they observed only two excitations, while in a 25-nm thick film only one. This is the expected behaviour for surface guided waves. In further experiments they report the existence of these excitations in semi-conducting silicon and in the insulator  $\text{Al}_2\text{O}_3$  (*Physical Review Letters*, vol 35, p 390).

## Interpretation and understanding in the emergence of language

The mother/child interaction is crucial in nurturing the infant's first efforts at talking, the mother often interpreting the utterance of a single word in a semantic rather than a literal way

How does a child find his way into language—the rich and complex system of syntax and semantics that will enable him eventually to communicate not only about the world outside, but about the world inside his head, the world of prediction, projection, abstraction and imagination? Whatever the path he takes, his mother is the guide—a point that received constant emphasis at the Third Symposium on Child Language, where many of the speakers were mothers who had literally lived with their research, making daily notes on the context, intonation of their infants' utterances and keeping a watchful eye on their own verbal behaviour in an effort to trace the first faltering steps into the world of words.

### "Private" languages

Although language at its most sophisticated is precisely the means by which man is freed from the constraints of the real and immediate world, early infant speech is very firmly tied to it. And so is the reciprocal conversation of the mother, which Linda Ferrier described (from observations on herself) as "repetitious, ritualised and context-bound". The first step the child makes is to try to "map" the utterances of his mother onto the situations in which they occur. And that is what leads to the idiosyncratic character of infant speech. For instance, who but Linda Ferrier and her daughter could have known that "pussy" meant drawing?—a private usage that came about through Ferrier's personal predilection for drawing cats. Similarly, because she responded to squawks and reaching movements by asking "Do you want this?", or "Do you want that?", "This" and "That" became generalised words in the child's initial vocabulary.

Those observations deal with the way in which babies learn the meaning of words—the first foray into semantics. A much more difficult and controversial issue has been the acquisition of syntax: how the child begins to structure combinations of words to make sentences.

Some psycholinguists have made the apparently paradoxical claim that the beginnings of syntax can be seen while the child is still at the stage of uttering single words. For instance, when an infant says "car", he may mean, "Look at that car" or he may mean "I want that (toy) car"; and you can tell which by listening carefully to his intonation which will vary systematically, according to what he means. Thus, the detection of syntax in early speech depends crucially on the interpretation

of the child's intended meaning, or to use the jargon of the field, his semantic intentions.

It hardly needs saying that no one is better placed to judge a child's semantic intentions than his mother, and that is how Patricia Greenfield came upon some new evidence for the semantic pregnancy of infant's monosyllables. Searching for clues in the limited conversation of her own small child and one other, belonging to someone else, Greenfield formed the impression that the decisive factor in what the children chose to comment on was its unexpectedness.

The question of choice arose because at the stage at which she was making her observations, the children had acquired enough single words to be able to choose which aspect of a given situation to put into one of them. For instance, the child might say "Car", or "Brrm-brrm", to indicate that the car was moving. She noticed that seeing a car going past outside, for example, the child was more likely to say "Car", but that on the point of pushing a toy car with which he had been playing, he was more likely to say "Brrm-brrm".

The principle on which he makes

his choice, Greenfield believes, is uncertainty—uncertainty in the technical sense in which it is used in information theory. The more uncertain, or unpredictable something is, the more information it contains. In the car example, the car outside was unexpected, whereas the child was already in possession of the toy one so that the only uncertainty lay in what it would do. And as the most obvious function of language is the communication of information, it seems very reasonable that the first aspects of his world that a child elects to encode should be those containing the most information.

The mother-bound, environment-bound nature of the whole process of acquiring language has clear and very important practical implications, especially for people who are trying to deal with children crippled by their failure to acquire it. Children do not, as Noam Chomsky is famous for having suggested, come into the world with the deep structures of Chomsky's transformational grammar already sitting conveniently in their brains, just waiting to be filled with suitable lexical items (words to us). They learn how to construct sentences slowly, at a rate that for instance Toni Cross of the University of Melbourne has shown depends very heavily on how the mother speaks to her baby.

### Motherese—a new language!

Toni Cross made a survey of what he calls "motherese". It is very conspicuous that mothers talk to their babies in quite different kinds of sentences from those they use in adult conversation. Motherese is the means by which mothers let their children down lightly into the labyrinth of syntactic structure—but what is the most effective strategy for doing that?

From her audio and video tapes on 16 middle class mothers with children between one and a half and three years old, Cross has concluded that the crucial point is how far the mother's verbal responses to the child reflect the semantic content of the child's own preceding utterance. If the mother is thus producing instant feedback the child can relate directly to his own effort at expression, he will progress very much faster in grasping the rules of syntax.

So once again, the emphasis is on meaning, or semantics, as much as on linguistic structure, or syntax. It is not enough for mothers to simplify the form of the sentences they address to their children: the actual message should also be relevant in a way that is clear to the child.



From the first, children embody semantics in their simple communication

# The ceramic engine prepares for take off

Ceramic components would allow the jet engine to operate at temperatures 300°C or more higher, thereby reducing fuel consumption markedly. Ceramics could even make the gas turbine a practical proposition for the motor car, allowing it to be produced and operated about as cheaply as a conventional petrol engine

**Nicholas Valéry**

In their constant search for improved efficiency and lower fuel consumption, the designers of jet engines are demanding materials that will withstand higher and higher temperatures. As the compressed gases enter the combustion chamber and are ignited they begin to expand rapidly and their temperature soars to over 900°C as they enter the turbine before escaping to the atmosphere. If the turbine entry temperature could be pushed up to 1200°C, the engine ought to give around a 20 per cent reduction in fuel consumption; at 1400°C, the improvement might be as much as 30 per cent. Put another way, a 2 per cent increase in efficiency would be equivalent to a 6 per cent reduction in fuel consumption.

But the problem is simply that even the best present day metals—the so-called superalloys based on nickel and cobalt—have already reached their limit of performance. Although their melting points are around 1350°C, alloys used in gas turbines experience a serious loss of strength several hundred degrees lower, when the problems of oxidation and “creep” set in. Over the past few years very small improvements in turbine entry temperature—of the order of 10°C per year—have been won at ever increasing cost. This has come mainly through cooling the turbine blades with air bled off from the compressor stage in the engine. But even this now has reached its limit. The latest gas turbines divert about 8 per cent of the compressor air simply for cooling the nozzle guide vanes and a further 5 per cent for cooling the rotors in the first stage of the turbine part of the engine. And the loss of power for cooling purposes has now begun to balance the improved efficiency that comes from operating at higher temperatures.

The ideal jet engine would, of course, be “stoichiometric” and use no excess air whatsoever. This would involve compression ratios in the order of 30 or even 40 to one and gas temperatures up to 2100°C. And although tungsten, molybdenum, niobium and tantalum have all been considered as candidate materials for a near-stoichiometric engine,

no way yet has been found around their catastrophic behaviour under oxidation. Nor has coating turbine blades with, say, niobium metal solved the problem: coated blades simply cannot be fabricated with the intricate ducts drilled in them for cooling. It is for this reason that attention has focused on the ceramic materials—and, in particular, on silicon nitride and silicon carbide.

Ceramics were first considered for use in gas turbines in the late 1950s when the Plessey Company in Britain discovered that “fully dense” silicon nitride could be produced simply by hot pressing silicon nitride powder in the presence of a small percentage of magnesium oxide additive. However, engine designers were soon disappointed with the material's poor impact resistance. Operating experience showed that even the hot part of the turbine towards the back of the engine had to be able to withstand the impact of debris from ingested birds and fragments of compressor blades as well as coke and other combustion products hurled through the turbine at speeds of over 2000 miles/h. But despite these problems, the hot pressed silicon ceramic was 60 per cent lighter than the superalloys, which meant that if some way could be found to use it the centrifugal loading on the rotating components (inversely proportional to density) could be significantly reduced—and hence the engine could then be made lighter. Lighter rotating parts would also lower the turbine's inertia and would consequently allow quicker acceleration and retardation of the engine. Moreover, compared with a raw material cost for superalloy parts of around \$6.3/lb, the new generation of silicon ceramics (made from some of the more abundant elements on Earth) were confidently expected to cost eventually no more than 20 cents/lb.

## Expansion versus conduction

Of the two silicon ceramics considered nowadays, the nitride ( $\text{Si}_3\text{N}_4$ ) has the lower thermal expansion coefficient ( $2.5 \times 10^{-6}/^\circ\text{C}$ ), which gives it excellent resistance to thermal shock—important in a jet engine which may have to be started up from cold three or four times a day. Silicon carbide ( $\text{SiC}$ ), by contrast, has a larger coefficient of thermal expansion ( $4.5 \times 10^{-6}/^\circ\text{C}$ ) but has much better thermal conductivity characteristics than silicon nitride, which would help soak heat away from the delicate turbine blades and dump it in more bulky parts, such as the shaft housing. The turbine designer has therefore to choose between the special attributes of either silicon nitride or silicon carbide, and between several different ways of preparing them—each of which has its own trade-off between strength and fabrication cost.

The original hot pressed silicon nitride

Figure 1 Variation of specific fuel consumption of a jet engine for different turbine entry temperatures and percentages of heat exchange. Ceramic components would give the gas turbine a fuel consumption as good as a diesel engine and better than a 1970 petrol engine (hatched region). Courtesy of Doulton Research Ltd

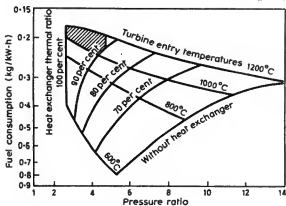


Figure 2 A 50 ton extrusion press for forming silicon carbide slab. Courtesy of British Nuclear Fuels Ltd



(HPSN) developed by Plessey yielded a material of somewhat variable strength (from 40 000 to 120 000 lb/sq.in), caused mainly by the presence of large grains, inclusions and even voids. More lately, the strength of HPSN has been enhanced (up now to around 150 000 lb/sq.in) as a result of further development at Plessey and Joseph Lucas in Britain and at Norton Company in the United States. But the high cost of processing an HPSN component remains its biggest drawback. "Despite the short time at processing temperatures (1750°C), the cycle taking only a few hours including heating and cooling, the scale up in quantity is expensive compared with batch furnacing," says Dr D. J. Godfrey of Admiralty Materials Laboratory, Poole. The HPSN is a hard, tough ceramic which can be machined only slowly, even with diamond tools, and the carbon hot-pressing die has a short life.

An alternative form of the same ceramic is known as reaction bonded silicon nitride (RBSN). Though not as strong (the best bend strength so far achieved is around 50 000 lb/sq.in) as hot pressed silicon nitride, it at least has the advantage of being easier to work. Reaction bonded silicon nitride is not as dense as HPSN, having between a fifth and a quarter of its volume made up of voids. Studies at both the Admiralty Materials Laboratory and the British Ceramic Research Association have resulted in commercial materials which are initially pressed and partially bonded to yield a machinable "compact". When this has been machined to the precise shape required, it is then placed in a furnace and the final nitriding reaction allowed to take place. The dimensional change that occurs during nitridation is less than 0.05 per cent. "This ease of fabrication contributes greatly to the economic advantage of RBSN," says Godfrey, "but although the furnace has a much longer life than a hot-pressing die, this is offset by the firing time

of several days."

Two processes are available for making fully dense silicon carbide. One is by hot pressing and the other by reaction (or self) bonding. Hot pressed silicon carbide (HPSC) materials are about as strong as their silicon nitride equivalents, but have the useful advantage of being electrically conductive. One material currently available from Norton Company in the United States has a bend strength of 135 000 lb/sq.in. Again, like hot pressed silicon nitride, the carbide ceramic is so hard that it has to be machined by diamond grinding; but, being electrically conductive, it can also be machined to shape by the cheaper process of spark erosion.

The self-bonded silicon carbides, though only about half as strong (75 000 lb/sq.in) as the hot pressed version, are much easier to work with. Made by mixing a small amount of silicon carbide and graphite powder with a plasticiser, self-bonded silicon carbide can be formed into various complex shapes simply by extrusion, die pressing or isostatic pressing. The "green" (unfired) shapes are then subjected to molten silicon in a furnace which reaction-bonds the mass into a strong, fully dense, impermeable component. This is the material that was first developed as a cladding for nuclear fuel by the UKAEA's Springfields Works near Preston and now manufactured and marketed (under the trade name Refel) by British Nuclear Fuels Ltd.

Low density versions of silicon carbide have also been developed—including silicon carbide particles bonded to clay, carbon and even silicon nitride—but all have turned out to have low strength and poor thermal conductivity. The choice for the jet engine designer is thus between the hot pressed versions of silicon nitride and silicon carbide and the self-bonded forms of silicon carbide.

### Solution in search of a problem?

As one might expect, a self-bonded silicon carbide such as Refel has much the same ease of fabrication and good dimensional control as reaction-bonded silicon nitride. However, Refel has about four times the thermal conductivity and strength of RBSN. "In general," says John Shennan of the UKAEA's Springfields Works, "the properties of self-bonded silicon carbide are more directly comparable with those of hot-pressed silicon nitride, but these properties are attained using a much more flexible process."

With its somewhat unfulfilled promise in nuclear engineering, Refel is, in a sense, still a solution in search of a problem. But it says much for the material that one leading US manufacturer of industrial and aircraft gas turbines, General Electric, has now also based its own ceramics research programme on a similar form silicon carbide. The original material, developed by Dr Svante Prochazka of the GE Research and Development Center, Schenectady, is a reaction sintered ceramic which is based on a very fine silicon carbide powder supplied as a by-product by Pittsburg Plate Glass Company. Unlike Refel, which bonds without any sintering, the GE material has to be cooked at 2100°C at atmospheric



pressure using a boron additive to stimulate grain growth. In tests, the GE material is said to maintain a fracture strength of more than 65 000 lb/sq.in at temperatures up to 1600°C. Refel, by contrast, experiences a sudden 50 per cent loss in strength at around 1400°C—due to the presence of small amounts of unreacted silicon, which reduce their volume by 10 per cent when they melt.

Lately, the GE researchers have taken their work a stage further and produced a lightweight material consisting of silicon carbide filaments dispersed in a silicon matrix. The silicon carbide provides the high temperature strength, while the silicon filler endows the composite with metal-like toughness and ability to bend under stress. The composite is produced by reacting molten silicon direct with carbon fibre, which is converted into silicon carbide. The space between the fibres is then filled with molten silicon. Again, fabrication is simple, the composite being precision cast with negligible shrinkage.

Ironically, much of the current interest in silicon carbide ceramics such as Refel and GE's composite equivalent rests not so much on their exceptional strength at high temperature, but more on their cheapness and low weight. Despite the rather limited production runs so far, mechanical seals manufactured out of Refel are already cheaper to fabricate than comparable components made from conventional tungsten carbide. It is this aspect that has caught the eye of the motor industry. While the US Environmental Protective

Agency recently reported that even if Detroit was to produce 10 million auto gas turbines per year made from conventional alloys, this would still account for only 15 per cent of the country's annual consumption of nickel. The availability of nickel supplies is therefore assured; but the cost of manufacturing such an engine using nickel alloys is likely to be too high to be practical.

At the British Association meeting in Guildford two weeks ago, Anthony Curtis, technical editor of *Motor* magazine, remarked that it would take a technological breakthrough—in particular, the development of cheap ceramic components—to make the gas turbine a serious rival to the conventional reciprocating engine for the motor car. "One piece ceramic power and compressor turbines would save a lot of money," said Curtis, "but such a development is almost certainly at least ten years off."

The gas turbine for the car may not make such high temperature demands on materials as does the aircraft jet engine, but with the motor industry's commitment to really high volume mass production (where every component has to be costed to within 0.1 pence) much greater emphasis is needed in ceramics research on actual production techniques—so that complex shapes can be made with repeatable accuracy and at guaranteed low cost. Perhaps more than anything else it is this kind of know-how that will ultimately determine how quickly ceramics become commonplace in aircraft engines of the future.

## Shock-absorbing biopolymers

Associated with collagen in its bodily structural role are polymers of complex sugar units which resist compression. An understanding of how these molecules interact and mutually influence each other is fundamental to an understanding of healthy tissues and may well throw new light on tissue deterioration

### Dr David Hukins

is a member of the  
Department of Medical  
Biophysics at  
Manchester University

Determination of the three-dimensional structures of biological macromolecules has been responsible for many of the successes of molecular biology. Most of this structural research has been concerned with nucleic acids and proteins. Now, X-ray diffraction experiments are beginning to provide the same kind of structural information for another class of biological macromolecules: the mucopolysaccharides of animal connective tissues. What are the mucopolysaccharides, and what can we learn from their molecular shapes?

Mucopolysaccharides (sometimes called glycosaminoglycans) occur in the ground substance, or extracellular matrix, which surrounds the relatively few cells of connective tissues such as skin, bone, cartilage and tendon. Research on mucopolysaccharides described here, and research on collagen described by Dr John Woodhead-Galloway last week ("Collagen—the universal body-builder," *New Scientist*, vol 67, p 582), are two approaches to understanding the structure and function of these tissues at the molecular level. The most obvious function of the extracellular matrix is to provide support to the tissue. Collagen fibrils resist stretching, while the

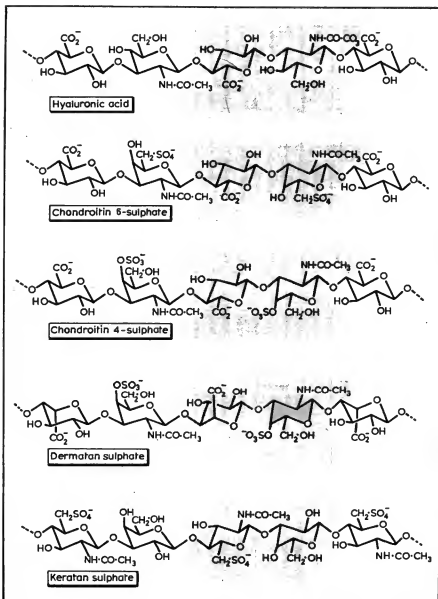
mucopolysaccharides resist compression by forming a highly hydrated network between the collagen fibrils. The electrostatic charge of this network influences the diffusion of ions, such as calcium, through the matrix. Its exclusion properties, which have been extensively studied by, among others, A. G. Ogston at Oxford and T. C. Laurent at Uppsala, influence the diffusion of large protein molecules. Thus the matrix also influences the transport of essential substances to and from the connective tissue cells.

Connective tissues are damaged by diseases like rheumatism and arthritis. Where two bones meet to form a joint, they are coated with cartilage, which acts as a self-lubricating material. Rheumatoid arthritis can erode this cartilage so that normal movements of the joint become severely restricted. Mucopolysaccharides appear in abnormal quantities in the urine of children suffering from inherited diseases like Hunter's and Hurler's syndromes, which result in skeletal deformities, dwarfism and mental retardation.

Three different research groups are using X-ray diffraction methods to study mucopolysaccharide structure: one in the United States,

directed by S. Arnott of Purdue University, and two more in the United Kingdom, directed by E. D. T. Atkins of Bristol University, and D. A. Rees of Unilever Research Laboratories. My own interest in this research began when I was working at Purdue in collaboration with S. Arnott and J. M. Guss. We found that the molecular shapes of the mucopolysaccharides do not immediately suggest how they perform their biological functions. To this extent our results have been disappointing when compared with structural studies on other macromolecules, which have often immediately suggested molecular mechanisms for biological processes; for example, Watson and Crick's double-helical model for DNA suggested a mechanism for the storage and replication of genetic information. Determination of the three-dimensional structure of mucopolysaccharide molecules is just one aspect of research, using the methods of biology, biochemistry and physical chemistry, which is aimed at understanding the detailed role of mucopolysaccharide structure in the functions of connective tissue. In the rest of this article I shall indicate the progress achieved and the problems that remain.

Figure 1. Chemical formulae of the mucopolysaccharides

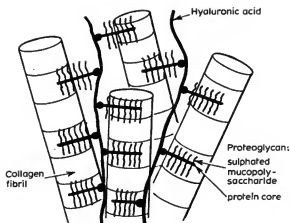


Mucopolysaccharides consist of chains of complex sugar units linked together in the way shown in Figure 1. In the figure, the repeating links of each chain are the two bracketed sugar units. Hyaluronic acid chains are longer than the others and contain about 5000 of these links, but chondroitin sulphate chains can have only about 50. Only hyaluronic acid always appears to have the same chemical constitution. The others, the sulphated monopolysaccharide chains, are less regular and the distribution of sulphate groups, in particular, is very variable. Despite this chemical complexity it is convenient to give names to the four idealised sulphated mucopolysaccharides whose formulae are shown in Figure 1. A particular single mucopolysaccharide chain might, for example, be most like the chondroitin 4-sulphate chain of Figure 1, while having some of the features of chondroitin 6-sulphate and dermatan sulphate along its length. The isolation and chemical characterisation of mucopolysaccharide chains from different tissues are important and technically difficult areas of connective tissue biochemistry. Two mucopolysaccharides, heparin and heparan sulphate, are omitted from Figure 1 because their chemistry is so complicated that their formulae are still uncertain.

The simple model for the extracellular matrix, of a three-dimensional framework of collagen fibrils filled with mucopolysaccharide, is capable of exhibiting a variety of forms according to the proportions of its components. Tendons, which are fibrous tension-bearing tissues, have a high proportion of collagen, while vitreous humour, which is a gelatinous tissue inside the eye, has a high proportion of mucopolysaccharide. Different tissues also have different proportions of the various mucopolysaccharides. For example, dermatan sulphate occurs particularly in skin, tendon and arterial walls, whereas keratan sulphate has a limited distribution and occurs mainly in the cornea of the eye, in cartilage and in the nucleus pulposus. (The nucleus pulposus forms the centre of the intervertebral disc; a "slipped disc" occurs when the nucleus pulposus bursts through the outer wall, or annulus fibrosus, of the disc.) Hyaluronic acid occurs in especially high concentration in the softer, more gel-like connective tissues, such as the vitreous humour of the eye, Wharton's jelly of the umbilical cord, and the synovial fluid of joints. Changes in the mucopolysaccharide content of tissues occur during ageing. M. B. Mathews and S. Glagov at the University of Chicago have shown that in cartilage the proportion of chondroitin 4-sulphate decreases while the proportions of chondroitin 6-sulphate and keratan sulphate increase (*Journal of Clinical Investigation*, vol 45, p 1103). Presumably different mucopolysaccharides confer different properties on the tissues.

Hyaluronic acid has a peculiar physical property: E. A. Balazs, of the Boston Biological Research Institute, used it to make a "viscoelastic putty", which flows under stress and which heals when it is cut and the surfaces are pressed together. It also has a unique biological function. B. P. Toole and

**Figure 2. Molecular organisation of cartilage** (This diagram is only intended to represent the kind of interactions which are believed to occur in cartilage. It does not represent the detailed structure of the interacting system and is not to scale.)



J. Gross, of Harvard Medical School, have shown that in some embryonic tissues the cells are coated with hyaluronic acid which inhibits the interactions between cells. J. R. Polansky and his colleagues have recently shown that at the appropriate time an enzyme, called hyaluronidase, removes this coating so that cell interactions can occur and the next stage in the development of the tissue becomes possible (*Science*, vol 183, p 862).

#### Like bristles on a bottle brush

In the extracellular matrix the sulphated mucopolysaccharides are chemically bound to protein to form a proteoglycan, where mucopolysaccharide chains resemble bristles on a proteoglycan bottle brush. Electrostatic interactions between the negative charges of the mucopolysaccharide chains and the positive charges on the molecules of the collagen fibril are then, in part, responsible for the organisation of the matrix. This model for the matrix structure was first proposed by M. B. Mathews, and since his proposal the interactions between collagen and mucopolysaccharides have been intensively studied. Recently quantitative studies of these interactions have been made by J. Blackwell and R. A. Gelman, of Case Western Reserve University in Cleveland, Ohio, using the technique of circular dichroism spectroscopy, and by B. Öbrink of the University of Uppsala, using light scattering. Although they have been used to compare the strengths of interactions for different mucopolysaccharides, these techniques tell us nothing about the three-dimensional structure of the interacting systems of collagen and mucopolysaccharides, so that this still remains an important question in understanding how mucopolysaccharides are involved in the structure of the extracellular matrix (*Biochimica et Biophysica Acta*, vol 342, p 254).

Modifications have been made to the original model for the extracellular matrix proposed by Mathews. One example is a result of the recent experiments of T. E. Hardingham and H. Muir of the Kennedy Institute of Rheumatology in London (*Biochemical Journal*, vol 139, p 565). They extracted both proteoglycans and hyaluronic acid from cartilage and then found that the proteoglycans could be bound to the hyaluronic acid. These results suggested that yet another interaction, between proteoglycans

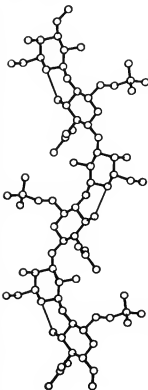
and hyaluronic acid, occurs in cartilage so that its overall organisation is believed to be something like that shown in Figure 2, which also incorporates features discovered by other researchers. In some tissues, particularly arterial walls, this simple model for the extracellular matrix is further complicated by the presence of another protein—elastin.

X-ray diffraction experiments have shown that the sulphated mucopolysaccharides, when extracted from their tissues, can form regular three-dimensional structures which consist of chains that are not highly coiled but are almost fully extended. Although we do not expect these regular extended chains to persist in the extracellular matrix, their negatively charged groups protrude into the surroundings so that they would be free to interact with positively charged ions, such as calcium, or with collagen. It is, therefore, possible that stretches of extended mucopolysaccharide chains might form aggregates which could be stabilised by positively charged calcium ions. Similarly these regular molecular shapes could be involved in the binding of mucopolysaccharides to collagen. Differences in chemical formulae between chondroitin 4-sulphate, chondroitin 6-sulphate and dermatan sulphate do not lead to any marked difference in the shape of the mucopolysaccharide chain. As S. Arnott has shown, keratan sulphate has a very similar three-dimensional structure, as in Figure 3 (*Journal of Molecular Biology*, vol 88, p 175). Blackwell and Gelman were able to relate the strengths of interactions of different sulphated mucopolysaccharides with collagen to the distribution of negatively charged side groups along the chain. It seems as if extended mucopolysaccharide chains are able to accommodate charged groups in a variety of positions, and that it is the distribution of these charged groups which is responsible for the subtle variation in biological properties between the different sulphated mucopolysaccharides.

Hyaluronic acid is capable of existing as regular extended chains, but it can also exist as another, less extended form. This form is more highly coiled than the other mucopolysaccharide structures and, until very recently, was believed to be a "double helix" in which two chains were wound around each other. Recent X-ray diffraction experiments have shown that the double helix model is incorrect and that hyaluronic acid can exist in a variety of regular forms in all of which the molecules consist of single chains. The molecular chains can be extended, like those of the other mucopolysaccharides, but as J. M. Guss and colleagues have found in one form they are less extended and more highly coiled into a shape like a corkscrew (*Journal of Molecular Biology*, vol 95, p 359).

It is clear that new results are emerging which are beginning to relate the structures of the mucopolysaccharides to their roles in the extracellular matrices of connective tissues. However, we have yet to define the subtle differences in behaviour between the various mucopolysaccharides with sufficient precision to understand their different distributions in tissues and during ageing.

**Figure 3. Regular three-dimensional structure of keratan sulphate.** (The thinner lines between atoms represent weak chemical bonds called hydrogen bonds. Only three links of the chain are shown.)



# Fisheries need managers, not owners

Conservation of marine fish stocks is threatened by the present emphasis on coastal state ownership. The Atlantic fishery commissions are being weakened just when they should be helped to strengthen their grip on commercial exploitation

**Tony Loftas**  
reports from Ottawa

Last week talks opened in Reykjavik on access by the UK fishing fleet to Icelandic waters once the country enforces its 200 mile fishing limit on October 15. Next week a special session of the International Commission for North Atlantic Fisheries (ICNAF) begins in Montreal to discuss quotas for cod, haddock, redfish and American plaice. Both the Canadian and American representatives will be pressing for a large reduction in the amount of fish taken from the waters off their shores. Fishermen in North America are pressing for unilateral action to protect their livelihoods. The United States already has a bill under consideration that would give the country jurisdiction over a 200 mile zone and pressure is being exerted in the Canadian House of Commons for a declaration of a 200 mile exclusive economic zone (EEZ).

At the close of the last session of the UN Law of the Sea Conference (UNLOSC), its president, Sri Lanka's Shirley Amerasinghe, relayed a plea from land-locked and other disadvantaged states for patience on the part of coastal states currently considering unilateral action. More than 30 countries have so far adopted or are thinking of adopting a 200 mile fishing limit and there are no signs of holding back. Mexico, for example, is now expected to pass legislation setting up a 200 mile EEZ before the end of the year. The most significant point in this trend, however, is the change in mood and new militancy in developed countries, in particular Canada and the United States.

Repetitive themes in the arguments of the fishermen for a 200 mile limit is that it falls within the current international consensus and is vital to conserve over-exploited stocks. Such themes are based on dangerous assumptions. One is that fish stocks can be managed more efficiently by one nation than by several

nations pooling expertise. Another is that all nations will in fact be reconciled to a general annexation of living marine resources over the most productive part of the oceans. Of course, some countries (among them Iceland) can plead special circumstances, but on the whole the fashionable arguments of conservation seem to be little more than fronts for other political or economic considerations. Even Iceland must have in mind access on favourable terms to the EEC. And could Canada, a country badly wanting a long list of concessions from the present law of the sea negotiations, really risk souring its case with a unilateral extension of its fishing limits? Nevertheless, events in the next few months could have serious implications for fishery management and future law of the sea negotiations.

## Tough line at ICNAF

The cry for a 200 mile fishing limit in Canada is prompted by the failing fortunes of the east coast fisheries and an inability in the eyes of Canadian fishermen on the part of ICNAF to regulate the countries exploiting fish stocks in the area. Speaking of the annual meeting of ICNAF, held in Edinburgh in June, the Fisheries Council of Canada reported that it was the last chance of members (other than Canada and the US) to act voluntarily and as a group of nations. "Now time has run out . . . The ICNAF partners were not prepared to accept Canada's proposals and we are now faced with having to decide on alternative measures of dealing with a worsening situation for Canada's fisheries." At the Edinburgh meeting the Canadians were asking for a 40 per cent reduction in the fishing effort, not quotas, of the other 16 member nations of ICNAF.

Even while the ICNAF meeting was in session, Canadian members of parliament from fishing communities were expressing doubts as to the possibility of enforcing such a cut in effort even if it were to be agreed. Speaking in a debate on 19 June, Mr Carter (St John's West) outlined the situation that so aggrieved his constituents. "In 1960, Canada's total groundfish catch was 723 000 metric tons, as opposed to 885 000 metric tons in 1973—an increase of 22.4 per cent. The same year, Russia's total catch was 258 000 metric tons, and in 1973 1 354 000 metric tons, which is an increase of 424.8 per cent . . . the grand total of groundfish caught in the ICNAF area in 1973 is exactly double the tonnage caught in 1960." He went on to point out that the total fish landings in Newfoundland, under all headings, was less than one half that in 1969, despite an increase in fishing effort and capability.

For some time, the Canadian authorities had been irked by what they considered to be the flaunting of ICNAF quotas by foreign

Incident in  
disputed waters  
1973



(REY-5) 5/29-(AP)—THIS PICTURE MADE AVAILABLE TODAY SHOWS CAPT. GUDDMUND KENNEDY AT BRIDGE OF HIS ICELANDIC GUN BOAT ANGRY WHILE ATTACKING THE BRITISH FISHING TRAWLER EVERTON, REAR, SATURDAY IN ICELAND'S DISPUTED FISHING WATERS. THIS PICTURE WAS MADE BY THE FIRST OFFICER OF THE GUN BOAT. (AP PHOTO)

fleets. In their time, the British, West Germans, Spaniards and Portuguese have all come under suspicion. With the failure to reach agreement at the Edinburgh meeting, plan B—the denial of port facilities to foreign fleets—was almost bound to go into operation. The Soviets with their factory ship flotillas were considered to be the worst offenders and, of course, gave the maximum publicity to Canada's determination to secure a better deal for its fishermen. On Wednesday, 23 July, Fisheries Minister Romeo LeBlanc announced the closure of Atlantic ports to Russian fishing ships, effective from midnight on Sunday. He said that repeated attempts by Canada to stop the overfishing had "met with no satisfactory response". He also fired a warning shot across the bows of the Spanish and Portuguese fleets which he said had "been involved in certain violations, using nets with undersize mesh and discarding large tonnages of species they don't want without keeping records as required by ICNAF rules".

Once again the Canadian fishing industry renewed its call for a unilateral declaration in favour of a 200 mile limit. "They've done it for polar bears, why not for fish?" quipped one spokesman. The press, espousing the national call to resource control, gave maximum publicity to the action and the issue. The arrival in Ottawa of Iceland's foreign minister Einar Agustsson at the beginning of August kept the pot on the boil. Speaking to reporters he said: "We have been hoping Canada will become our ally by assuming control over a 200 mile area, too."

Prime Minister Pierre Trudeau endeavoured to put the issue in perspective on 7 August, pointing out that "we still find it better to get multilateral action and international recognition . . . than to act unilaterally . . . another point I must make, which I think will make you understand why the law of the seas route is better than unilateral action, is that we're asking a devil of a lot of things; special treatment for Canada, as it were, for this law of the seas. We're asking for rights beyond the 200-mile, and we're about the only country that is doing that because of the special extension of our shelf, mineral rights and even fisheries rights."

The Canadian Prime Minister was careful not to deny the possibility of unilateral action, only the probability of it at the present time with UNLOSC still in progress. The stage was set for discussions first with Spanish fishery officials during that week and, from August 25 to 27, with a Soviet delegation. Both delegations discussed the Canadian proposals for the conservation and management of fish stocks off Canada's Atlantic coast first advanced at the June meeting of ICNAF and scheduled for further discussion at the forthcoming one in Montreal. The Canadian side stressed the importance attached to these proposals and their possible implications for the future of ICNAF. The stage has thus been set for next week's meeting. Canada, supported by the United States which has already threatened to leave the Commission, is likely to present a tough and uncompromising front to the nations that it believes are ignoring the

long-term needs for the protection of viable fisheries off the east coast of North America.

ICNAF's problems result from the need to manage several stocks of fish each of which can occur as by-catches during fishing for the target species. For example, tons of dead haddock may be discarded during trawling for cod once the limit set for the by-catch has been reached. Apart from the obvious waste, this loss is made more serious because most stocks of such demersal fish are either fully exploited or over-fished. The demersal fishery can no longer continue to expand as in the past and stocks must be efficiently managed. Beneficial measures such as the control of net mesh sizes and the size of fish landed have been introduced. In 1972 the Commission also introduced quotas on important stocks and allocated shares to each of its members. Now the authority of ICNAF must be increased.

### Stronger management needed

Unfortunately, the need to bring together the various elements of fishery management and their ultimate expression—strict control of the amount of fishing—is occurring at a time of growing interest in marine resources in Canada, particularly among those communities that have traditionally exploited them. Action in fisheries has become inextricably entwined with local political issues. As one Newfoundland parliamentarian put it "we did not relinquish 400 years of independence to become an economically deprived province of Canada. . . . We demand the right to be given the means to develop our natural resources and preserve our society and our way of life according to our own priorities." Not unnaturally in this climate of opinion, every apparent failure of ICNAF or its member states is seized upon as much out of parochial interest as any long-term national aim.

The hard-line approach of Iceland, as indicated in last week's talks, will inevitably encourage those Canadian fishing interests who are pressing for the abandonment of ICNAF in favour of wide fishing limits. The Canadian representatives at next week's meeting are unlikely to change their present demands—a considerable reduction in fishing effort and rigorous application of rules and procedures already agreed with ICNAF. Fortunately, they will also have in mind the fact that the Atlantic fishery commissions, dealing as they do with sophisticated long-standing fisheries, have been reasonably successful. In the past they have proved as good as their scientific information, sometimes as good as the more powerful commissioners, but always they have been developing techniques of fishery management.

Good management, not coastal state control, ensures that fishery resources are exploited to the full in a sustainable way. Discussions should be centering not on the dissolution of commissions, but how to strengthen and improve them throughout the world. The question of ownership of marine resources belongs to another forum. It does not necessarily mean the exclusion of foreign fleets, nor does it lead perforce to the conservation of resources.



# Setting fire to damp brains

Next week the BBC launches two new school science television series, *Physical Science* and *Biology*. Here one of the programme producers describes some of the research and planning that went into preparing the series

## Dr Peter Baker

is a television producer working with the BBC School Broadcasting Department. He is currently responsible for the new series *Physical Science*

*Ideally—Educational television programmes in science are not substitute lessons. They offer an experience complementary to the classroom experience. Their effectiveness is not properly measured by tests of straight recall—more by the intangibles of motivation, stimulation of appetite. Viewed once they are ephemeral. Viewed more than once, recorded if possible and used selectively, they can have a variety of functions. They can introduce a topic, or summarise for revision, or provide specific visual resource material. They can provide background and perspective.*

*In practice—Many teachers use them that way. Many don't. Some television programmes are soft options, 20-minute fillers. (And the programmes aren't always as good as they should be either!)*

When a random selection of undergraduates at eight universities was recently invited to give opinions on school science, those specialising in science were almost unanimous in their attack on school science as "boring", "over-theoretical", "completely exam-oriented", "exercising the memory rather than the intelligence" (*Problems in Science Education and the Possible Role of Television in their Solution*, IBA). Not unexpectedly there was general criticism from the non-scientists too. School science, they claimed, was "geared in favour of the future specialist", "uniformly mysterious and boring", and "quite out of touch with the problems of everyday life".

I suspect that few science teachers would be particularly surprised to learn of those opinions. Many are dissatisfied with the status quo but feel themselves trapped by "the syllabus" or "the exam system"—things that they have little choice but to go along with in the short term. They may believe that a different syllabus, or a different exam system (or none) would be better but, whatever they desire, change in the educational world is slow, even when a great many people believe there's need for it. Also, teachers can

feel very isolated from each other, or from their colleagues in other schools, and co-ordination is not helped by a highly decentralised educational system.

A number of curriculum development projects have emanated in the past few years from the Nuffield Foundation, the Schools Council, and the parallel Scottish groups. Changes are afoot, though again the influences spread but slowly. (And some would say that few of the schemes are particularly radical when viewed against a backdrop of the kind of scathing criticisms quoted above.) Nevertheless, there can be few schools in the UK where the influence of some aspect of the various schemes has not been felt to advantage. Individual teachers are now adapting the new ideas to their own circumstances and their own preferred ways of working. Frequently they absorb some part of several schemes—some Nuffield O-level, some Nuffield secondary science (for less academic pupils), and maybe some of the Schools Council Integrated Science Project.

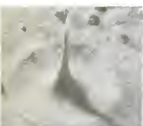
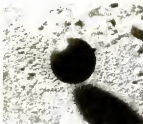
That is the educational background against which any new series of science broadcasts must be seen. The BBC can have a role in the dissemination of new and good ideas. There's no point in programmes being ultra-radical or they will preach only to the converted. They must somehow embody the spirit and philosophy of new thinking while being irresistible fare for the half-convinced, and even the not-at-all convinced.

Actually, it's less impossible than it seems, simply because the nature of a television offering is to complement the classroom experience, not to try to do the same job. It doesn't so much teach as offer a synthesis of visual material which wouldn't otherwise be available. For example, film is gathered from many countries as well as being specially shot. What physics teachers would be able to resist making use of film which employed special optical techniques to make sound waves visible? Maybe one teacher would wish for associated equations to be detailed on the screen as well. Another would be glad to forfeit that in favour of a wider range of visual fare, a more comprehensive linking of ideas, maybe even outside the boundaries of physics. But both the true-blue physicist and the integrated-science man will find the basic offer too good to refuse. So long as teachers are prepared to be opportunistic in their use of broadcasts, and so long as television programmes are good, there should be some dishes in the feast to suit almost everyone's taste.

Obviously it is important to get the basic choice of topics "right". Back in the 1960s the Newsom Report expressed great concern for the "neglected 50 per cent"—the pupils



At work on the film for *Chemical Technology*, made at ICI's Billingham Teeside ammonia plant



Splash model in a fluidised bed of sand

whose lack of academic prowess earmarked them for society's less coveted and less well-paid jobs. Non-academic pupils want their science to be practical and realistic, that was the message—science related to their lives and interests. Syllabus planners have attempted to get more imaginative schemes to take root ever since. For years the BBC ran the Science Session series with these ideas conscientiously in mind. In its time it covered everything from car mechanics and domestic electricity to child-care and communication. Devotees valued the programmes highly and many bemoaned the passing of the series to make valuable air-space available for the two new ones. But idealism is not sufficient in the jungle and the dominant demand among teachers is still for hard-core science.

So the two new series are "mainstream". They are designed to be of value over a wide range of ability between the ages of 13 and 16 years, and to be useful in conjunction with just about any syllabus scheme dealing with physics, chemistry or biology whether "traditional" or "progressive". The choice of topics has been determined not just by intuition and expert advice, but by thorough-going market research.

Normally when planning a new series, we simply talk with teachers and go to the main curriculum developers for advice. But previously most series had been keyed to particular schemes—Nuffield Physics or Nuffield Biology for example. For the new series the intention was to strike wider. A survey carried out by Education Officers of the School Broadcasting Council (the body of educationists which advises the BBC on school broadcasting and which stands sponsor for its schools programmes) had indicated that a period of consolidation had set in—that teachers were selecting and making their own synthesis of the various schemes. The SBC recommended two series not linked to any single development project. The survey had shown that most pupils in the designated age group were taught science by separate subject teachers, so full "integration" seemed unrealistic at this stage. But Physical Science would include both chemistry and physics material—the inclusion of chemistry at this level is an innovation so far as BBC school television is concerned.

### Choosing the right topics

As the producer of this particular series, I considered that I needed a firm statistical basis for the emphasis in approach and choice of topics for the limited number of programmes that resources could meet (ten colour programmes in each series in fact\*). There was no single curriculum development body to provide the detailed cross-section view that I felt was needed—I wanted to know what teachers were actually doing, and what they actually wanted, as opposed to what various groups felt they were doing or should want. So I designed a questionnaire which was eventually enlarged to include the Biology series as well. And the School Broadcasting Council provided the facilities for

large-scale mailing and helped with the analysis of results. The final questionnaire was sent to a random sample of 600 heads of science departments in secondary schools throughout Britain.

A vital part of the questionnaire aimed to determine the most sought after syllabus topics as possibilities for television treatment. A total of 112 topics between Physical Science and Biology were presented for selection—culled from an analysis of the whole range of Regional Examination Board syllabuses. The preferences were very marked. There was a clear ranking order topped in the case of Physical Science by radio-activity, atomic theory, kinetic theory, the periodic table and the chemical industry. It was fairly easy to select about 15 topics for inclusion in each series that commanded much support.

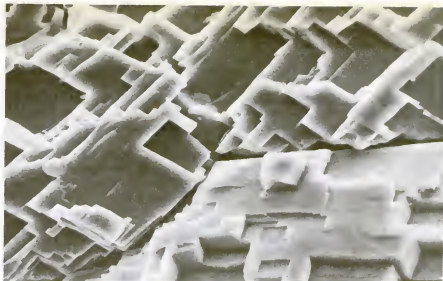
Such information is only a starting point though—raw material to be processed into television programmes using production skills and experience of programme psychology. The problem for Physical Science was to find ways of making often abstract ideas visual, and then to make them compulsive viewing!

The average school pupil (as opposed to the high-flier, the science natural) is not highly motivated. Quite probably the average 15-year-old has decided two years ago that he'd rather not be at school. The teacher switches on the television set, but the pupil doesn't necessarily connect with his attention. His interest really has to be "grabbed". In the first minute you have virtually to serve up a commercial for the remaining 19 minutes of the programme. Equally you have to "grab" the teacher's attention from the outset—generally his or her overriding concern is the nitty gritty of the syllabus and examination pressures. So to start with, your advertised programme titles must be very direct—so much so that they'd be positively off-putting for any other audience.

Thus you are poised in another delicate balance, pleasing the teacher and pleasing the 15-year-old—the two demands are by no means easily reconciled. (Why should the teenager be interested in the imaging of sound waves?) A school programme has to be interesting in its own right. Never mind whether you ever wanted to know about chemical technology—if you're watching, adult or 15-year-old, you've a right to feel glad you're watching.

Despite the daunting prospects of meeting such criteria with topics like the periodic table, all the top five physical science questionnaire topics form the basis of individual programmes in the series of ten. Examples of the conversion of raw questionnaire data into viewable television include those that reflect a demand for atomic theory, the periodic table, and kinetic theory. The demand for atomic theory is combined with other high-demand topics (for example "the variety of atomic arrangements in substances"—number 9 on the preference list) and translated into television terms as follows. "Microscopes and Molecules" is an attempt, in visual terms, to bridge the gap between the large scale, complex and diverse

\* The programmes in the Physical Science series are: "Mastery over Metals", "Elements of the Periodic Table", "Microscopes and Molecules", "Fluids", "Chemical Technology", "Energy Utilisation", "Oscillation", "Waves", "X-rays and Radioactivity", and "Free Fall".



Etched surface of aluminium. An SEM picture for the Physical Science series provided by the University of Aston

world we see around us and the relative orderliness and simplicity at the atomic scale—a sort of super zoom. The programme uses modern imaging techniques: conventional microscopes, electron microscopes, scanning electron microscopes, field ion microscopes. We see materials at increasing magnification until we image atoms and molecules themselves. En route we get insights, for example, into the microstructure of metals—microstructure related to macro-properties. The programme tells a story and offers visual interest and surprises. (For example, it includes scanning electron microscope film of LP microgrooves, showing the

stereo patterns like furrows in a field.) It makes no great demands on abstract thinking, yet the brighter pupil will find a higher level of appreciation within it. It will, after all the indirect evidence of the school laboratory, help to make atoms and molecules seem more "real".

The periodic table demand becomes, simply, "Elements of the Periodic Table". I find the programme difficult to describe in a few words. But apart from making the plausibility of the periodic classification a fairly easy ride, even non-chemists (and rebellious 15-year-olds) should gain some insight into the beauty and fascination of chemistry.

The kinetic theory demand is combined with a demand for technology in a film titled "Fluids". I've long wondered why fluidised beds aren't standard pieces of school equipment—they make the molecular and kinetic ideas of fluids so very accessible. But, as I've discovered, they are tricky to make and operate. The programme, however, will fill the gap for the time being. The technology topics in the programme are hydraulics and aerodynamics, including some spectacular film from the US Federal Aviation Agency.

Clive James in a general comment on television programmes, presented a most apt message in the critic's page of the *Observer* recently. It is a lesson to be heeded by teachers and science producers alike. "Focused, television can set fire to a damp brain at 200 miles. Unfocused, it won't even light up your eyes."

## Semiconductor scene

# New blocks for the computer builder

While the fashionable "microprocessor" may prove invaluable for simple tasks like controlling instruments and input/output devices, the real revolution in computer design is more likely to come from the new "general purpose" LSI modules based on bipolar TTL and ECL technology

### David Aspinall

is professor of electrical engineering at University College of Swansea, University of Wales

The design of large computers has had a profound effect, in turn, upon the design of their basic logic elements, which these days are assembled as small and medium sized integrated circuits in the surface layer some 10 microns thick on a wafer of silicon. These wafers, mounted in small packages, are inserted into interconnection circuits etched on to printed circuit boards. The dominant technology has been transistor-transistor-logic (TTL) but is now being followed by complementary metal oxide semiconductors (CMOS) and, for high-speed circuits, there is emitter coupled logic (ECL) (see *New Scientist*, vol 65, p 12; vol 66, p 550; and vol 65, p 554 respectively). These elements are cheap because of the large volumes produced for the computer industry. They are also commonplace in special purpose equipment for control, communication, and instrumentation.

But as the semiconductor technologists have learnt to pack more and more logic circuits on to a silicon wafer (now well over 1000), problems of how to interconnect the circuits and to decide what final circuit is worth

offering as a standard large scale integrated (LSI) component become very significant.

Interconnection may be carried out by using tracks of highly doped silicon. But this uses silicon surface areas ("real estate") which otherwise could be employed as sites for active or passive circuit components, such as diodes, transistors or resistors. However, the surface layer is protected by a thin layer of silicon dioxide which can also act as an insulator between the circuit components in the silicon and a conductive layer of metal evaporated on to its surface. Interconnections may therefore also be etched in this conductive layer and consequently not take up valuable silicon real estate.

As the complexity of the circuit increases, the need then arises for more than one layer of interconnection. Although consecutive layers of metal and insulator may be placed on the surface of the silicon, unfortunately this presents many technological problems. The cycles of photo-lithography, diffusion and surface passivation, which are involved in the placing of elements on to the surface, leave

a surface which is not perfectly smooth. There are micron high mountain ranges which present formidable obstacles to the thin conductive track. And as a track passes over a precipice, there is a good chance that the strain will cause it to break. As every layer of insulator or metal is applied, the number of mountains increases, and the problems are aggravated. There are also problems associated with the alignment of the track with the circuit components beneath it.

Semiconductor technology can cope with large circuits involving irregular arrays of identical elements, interconnected by a regular pattern of tracks which can be achieved by a single layer of metal. Such circuits can be identified by the computer manufacturer as components of memory systems. The random access memory (RAM), comprising an array of bistable elements, is now common in both bipolar technology (similar to TTL and ECL) and the unipolar MOS technology. A typical module of 1024 bistable elements may be arranged to store 1024 words of eight binary digits (bits) in parallel. They represent a general module which may be used by all computer manufacturers in a wide range of applications. There is a large market for them, which permits long production runs and competitive module prices from the manufacturers.

#### Search for general purpose module

The initial cost of developing a complex LSI module can amount to tens of thousands of pounds. This includes the cost of design and manufacture of the masks for the lithography stages of the production cycle; the cost of designing test equipment and documentation for all the stages of manufacture and tests; and the cost of supplying documentation for the users of the circuit and the necessary market support. The manufacturing stages—particularly if a complex interconnection pattern is involved—are fraught with difficulties and the manufacturer must pay a price to learn how to achieve a high enough yield. There must be confidence in the market for any new circuit before its

development phase can begin.

There are, of course, certain markets which are fairly obvious outlets for mass produced LSI circuits—including the memory, calculator, and electronic watch markets. But it is difficult to identify the LSI circuits which are generally required within the processors of computer systems. A system manufacturer may settle for a well proven semiconductor LSI technology, and develop his own design techniques to exploit it to produce economic circuits for his needs. By contrast, the semiconductor manufacturer must find a class of LSI circuits which are generally required by all system designers. The way they must do this is to examine computer systems and partition them into sections which may be profitably identified as LSI circuit modules.

A typical computer system is shown in Figure 1. Information is fed into the computer by means of peripheral input devices, and is obtained from the computer through the output devices. Both sets of devices are controlled by processes within the computer. The information held in the memory comprises both the data being processed and the instructions of the programs which define the processes to be carried out in the process.

There are several situations concerned with the provision of input/output devices and their control which suggest a role for LSI components. Since their specifications are affected largely by the nature of the devices, rather than by the memory or processor, we will not consider them in any more detail here. The memory has already been identified as a candidate for LSI, but let us consider its relationship to the computer processor in an effort to identify the major features of the boundary of the processor.

By excluding the input/output devices, we are left with the block diagram of Figure 2. Within the processor there must be a register of bistable elements which memorises the address of the next instruction to be obeyed. At the appropriate time, the contents of this register are presented at the "select" port of the processor and routed to the memory to select the register of bistable elements which holds the next instruction, and to open up the communications channel within the memory to allow the instruction to be read from the bistable register in the memory in the "read" port of the processor. The instruction is manipulated in the processor to specify and control the required operation. This includes calculation of the address of the data operand in the memory. This address is presented at the "select" port of the processor to find the bistable data register in the memory. Data may then be routed from this register to the "read" port of the processor or routed from the processor "write" port in order to be stored in this data register. A similar mechanism may be employed to enable information to flow between the processor and the input/output devices, which may be arranged to appear as images of registers in a memory.

Information passes through the ports of the processor in the form of many bits of data in parallel. If  $n$  bits are required to

Figure 1 A typical computer arrangement

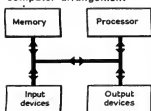
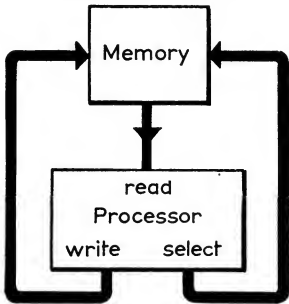


Figure 2 Processor-memory relationship



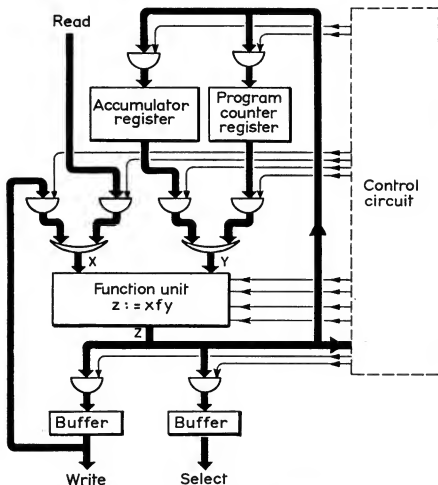


Figure 3 Data paths of a typical small processor

select from one of  $2^n$  registers in the memory, then 16 bits selects from 64 k registers ( $k=1024$ ). Data operands and instructions may be typically 16, 24, or 32 bits long. Thus the major amount of logic elements and bistables within the processor are those concerned with the routing and manipulation of parallel words of information. This is termed the "data paths" section of the processor; Figure 3 shows the "data paths" for a small processor.

The "program counter register" which holds the address of the next instruction is shown alongside an "accumulator register" which is used for storing intermediate results. These have gates to the port Y on the input to the "function unit". The output of the "function unit" port may be copied to either register or to the "write" or "select" buffers and to the "control circuit". The "read" port and "write" buffer are gated to the other input port (X) of the "function unit". The ports X, Y and Z are each typically 16 bits wide, and the "function unit" is capable of carrying out several functions (f) of the form  $z := xfy$ . The function and gate control signals are generated by the "control circuit" in the correct sequences to enable the complete cycle of activities required by each instruction (fetch instruction from memory, decode instruction and calculate operand address, fetch operand from memory, process operand in function unit either by one or several passes through the unit).

Attempts to partition the data paths into logic modules corresponding to the multiplexer gate for port X, the function unit, and

buffer unit, reveal that only modestly sized circuits can be placed within the practical packages that can be manufactured economically. For example, a function unit package to perform up to 16 functions on 16 digit operands would require 4 pins for the coded function and 16 pins for each of X, Y and Z, which could mean over 50 pins in all. With present technology, 14-pin packages are common while 40-pin packages are rare.

The alternative form of partitioning which takes vertical slices of the data paths and packs the entire circuit for two or four bits of the data paths into one package is a practical proposition. If a 2-bit slice is taken, then eight such slices may be assembled in parallel to produce a 16-bit processor. The number of pins required by the 2-bit slice comprise six for the memory ports and 12 or 14 for the control signals, giving around 20 pins in all—which is within the capability of economic package technology. Thus a data path module can be identified as having general features which can be exploited by the designers of digital computers.

### Control circuit

This is only half the problem, because the data paths must also be controlled by a unique control circuit which gives the processor its identity as an individual product. The control circuit takes the data paths through the sequence of activities mentioned above. Within each activity, the control signals must assume a sequence of patterns, each corresponding to a state of the control circuit. These patterns may be stored in a memory—just as the instructions of the program are stored in the memory of the computer. Alongside each control pattern there must also be stored the address of the next control pattern of the sequence. It is a feature of most programs that the next instruction to be obeyed is usually to be found in the next address location to the one currently being obeyed. A counting mechanism, external to the memory, keeps track of the next location. Jumps to other locations are often necessary and are usually "conditional" upon data processed by the present instruction. Thus, for complete generality, two addresses are stored alongside the control pattern: the first address is that of the location normally accessed next; the second address is that of the location to be jumped to, out of sequence.

A control circuit based on such a memory is shown in Figure 4. Each register in the memory is divided into three sections. The length of the control pattern is determined by the number of control signals required by the data paths. The number of bits in both the "next address" and "jump address" sections is determined by the number of registers in this memory. As a register is selected by the address in the "select buffer", the "control pattern" is sent to control the data paths which, in turn, open up one of the gates of the address sections, or provide the next address to be loaded into the "select buffer" to define the next state required.

A module of this type is complementary to the data path module described previously.



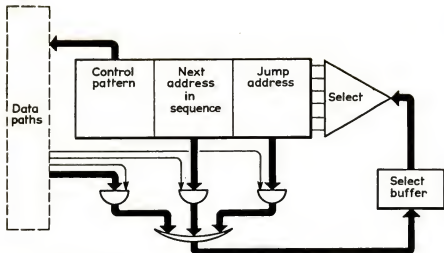


Figure 4 Control circuit based on memory modules

Together, they form a set of general purpose processor modules which provide the basic facilities required by the designers of digital computers. With them, the design process becomes one of choosing an appropriate number of data path modules to define the size of the computer and the writing of sequences of control patterns to achieve the required set of computer instructions. The latter process is termed microprogramming, and was first suggested in 1951. The microprograms are placed in the memory of the control circuit. This memory can be a "read only" type (ROM) and once the patterns have been written into it they cannot be destroyed

by normal operation of the computer and become a permanent record of the control sequences required by the designers.

#### Present situation

Modules of this type have become available recently and are being evaluated by computer designers. Those based upon the bipolar process (TTL and ECL) permit one pass of the data path circuit in approximately 125 nanoseconds, though many passes may be required to complete a typical instruction. Their performance compares well with that offered by the so-called microprocessor modules, which have been available for a year or so.

The microprocessor modules include both data path and control circuit in one package and are based upon unipolar MOS technology. The instruction sets provided in these microprocessors enable simple programs for special tasks in instrumentation control and the management of input/output devices.

The newer sets of processor modules offer the possibility to design a wide range of instruction sets which would permit more complex programs. If they are successful and become accepted, then their price should fall to a level at which most data processing equipment manufacturers can afford to use them. Before they can use them, however, they must learn new skills which replace those they have developed to design control circuits based upon conventional logic gates and bistable elements.

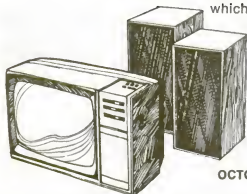
# GIVE YOUR TELEVISION HI-FI SOUND

**-exclusive tuner  
constructional design**

Our TV tuner receives the signal from the TV aerial and produces an audio signal which can be fed into your hi-fi equipment. The result is not only high quality sound but also a high quality video signal which can be fed back into your set to improve picture quality. The tuner consists of a printed circuit board

which can be either mounted in a small cabinet or installed in existing equipment.

Full details in this issue. We've also got a feature on progress in multiphonic organs and a resistor survey.



## WirelessWorld

OCTOBER ISSUE, 35p

# Technology review

## Shadowing a \$600 million gunboat

The \$600 million nuclear-powered aircraft carrier USS Nimitz this week ended a flying visit to Britain. Farooq Hussein viewed the vessel and looks at its strategic value.

USS Nimitz, with a displacement of 95 000 tons, is the first of three US nuclear-powered aircraft carriers. Its sister ships Eisenhower and Vince are still being built. The Nimitz class carrier programme has already been something of a political nightmare for the Navy. Because of the enormous expense and questionable strategic value of such large carriers it is considered unlikely that any more will be built, especially because of Congressional opposition to the programme.

In order to warn against attacking missiles, hostile aircraft, and ships, the Nimitz is bristling with radar and electronic warfare (EW) antennae. To extend its surveillance "horizon", Nimitz is data-linked to the nuclear-powered guided missile cruiser USS South Carolina by the Navy Tactical Data Control system NTDC. Radar and sonar data in the South Carolina's range is immediately available to Nimitz. In addition, Nimitz has one Hawkeye E-2B early warning radar and EW aircraft airborne at any one time. All EW and surveillance information is processed in Nimitz's Combat Information Centre using Univac AN/UYK-7 computers.

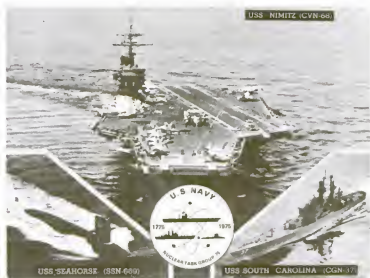
However, only a single attacking missile in 20 need penetrate the ship's defence to seriously damage its electronic armour. And Nimitz's radar profile is so large and distinctive that the "island" can be distinguished from the deck on a radar display screen.

Soviet warships, spy trawlers, and "Bear" reconnaissance aircraft have been

shadowing the Nimitz since it left Norfolk, Virginia, after being commissioned in May. Captain Bryan N. Compton, Commander of the Nimitz, explained that the Soviets had conducted electronic surveillance with "good manners". While gathering electronic intelligence on Nimitz, the Soviets are completing the first of Two Kiev class aircraft carriers. The Kiev

Any military command of over 6000 men is a heavy responsibility for one officer. But Nimitz's captain explained the problems of maintaining discipline with ease and confidence. Behind him on the bridge stood an armed bodyguard, one of the 74 marines that police this vast ship. The US Navy has decided on a new approach to discipline aboard the Nimitz. Its crew is a miniature cross-section of American society with all the luxuries of

*USS Nimitz—too vulnerable to be of strategic value?*



ships are half the displacement of Nimitz and appear designed to employ vertical take-off aircraft and helicopters only.

Nimitz is so vulnerable that its strategic value, especially for \$600 million, is questionable. There is no doubt, however, that it is a rather impressive "gun boat" with which to exert political pressure and influence.

shore life from colour TV (three channels) to mail order shopping. The grievances and questions of any member of the crew can be brought directly to the attention of the ship's Executive Officer—even anonymously if necessary. But as the captain himself pointed out, asking does not mean that a satisfactory answer will be forthcoming.

## No holiday for busmen

Busmen may soon have to turn their hand to extra jobs in between driving their buses to forestall the necessity of massive government subsidies to bus operators. According to Dr F. V. Webster of the Transport and Road Research Laboratory (TRRL) such labour flexibility is the only viable strategy open to bus companies if they are to survive in anything like reasonable shape.

Webster's predictions are the result of TRRL work on a model to predict bus patronage. The model has been used to examine two situations: one where bus operators have to break even; the second where the aim is to hold patronage at present levels.

At Wednesday's annual conference of the Association of Public Passenger Transport, Dr Webster told delegates that the TRRL studies put the choice for the bus industry: "somewhere

between letting events continue more or less as they have done in the past under a break-even constraint and losing up to one half of the passengers by 1985 or holding on to present patronage levels at a mounting cost which by 1985 could well be of the order of several hundreds of millions of pounds per annum (at 1975 levels)".

Although the decline in bus patronage has been halted in the past two years, Webster warned: "the downward trend may return". Webster's idea for halting the decline is to reduce the ratio of crew hours paid to actual crew hours worked, from the present norm of 1.6 to around 1.2. Such a reduction would mean a 25 per cent saving in crew costs. Because labour is 40 per cent of an operator's costs, a 10 per cent overall reduction would result. "If fares were then dropped by the same amount, patronage would increase by probably 4 per cent over the industry as a whole. This would amount to an

extra 300 million passengers a year. And if peaks became sharper in the future, the benefits from economies of this type could be even greater," he said.

Webster proposes that these cuts can be achieved by: switching drivers from buses to, say, delivery vehicles during off-peak periods; putting them on to dial-a-ride services (which generally operate off-peak); and even redirecting crew to cleaning, servicing, and office duties during "spare" time.

The idea of a joint passenger/freight service using the same vehicles is currently being investigated for the TRRL by a consultant. Carrying freight in the shape of Her Majesty's mails has already been combined successfully with passenger operations by British Rail—and on the road, in the case of the "postbuses". There are now about 70 of these combined buses and postal delivery vans, mainly in Scotland.

## Jitter bugs digital engineers

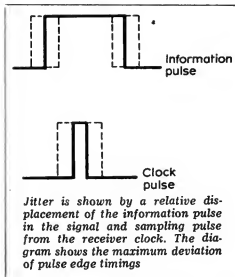
By 1985 about half Britain's telecommunications network will be based on digital transmission techniques. But as last week's Institution of Electrical Engineers conference on telecommunications transmission clearly demonstrated, there are still problems to be resolved. One of the most exhaustively researched is jitter—fluctuations in signal timing which can lead to transmission errors.

At present local telecommunications networks employ one digital technique—pulse code modulation (PCM)—to transmit 12 telephone conversations over a line which previously carried only one. PCM involves sampling a signal at regular intervals and converting its amplitude to a binary number which is then transmitted. This process is carried out on each line in turn—time division multiplexing (tdm). Here jitter presents few problems because telephone communications are relatively insensitive to distortion. But when digital networks become as complex and long-range as the Post Office envisages, it will become a

problem of some magnitude.

Jitter arises in intermediate stages in a network when the digital signal must be converted back to analogue form or reconstituted for switching. Because digital tdm takes a "block" of digital pulses from each line in turn and sends them in "bundles" of blocks, signals from different lines are mixed up. At the receiving end these signals have to be sorted out. To do this, a receiver must know exactly when each of the blocks begins. The receiver looks at a steady stream of pulses and must know when the pulses from each of the original lines begin.

The receiver thus needs some kind of clock. The most obvious timing mechanism is to send an accurate clock signal which tells the receiver when each pulse begins. But this would mean a serious waste of bandwidth. Fortunately, there is a solution readily to hand. For the actual tdm signal itself contains enough information to derive a clock signal from it. For example, among the



many combinations of digital "ones" and "zeros" in the signal will be strings of alternating 0,1's. These appear as a square wave which has a frequency component at the pulse sending rate. Thus suitable filtering and processing can abstract the required frequency and therefore a clock signal.

But processing and filtering circuits are not perfect, so the derived clock can be fast or slow—only a little, but enough to make the receiver look at the digital pulses at the wrong time and therefore make mistakes in reconstituting the original signal. This is jitter. It means that the signal becomes distorted in amplitude and phase.

As digital networks become more complicated, controlling jitter becomes more important. For example, it affects the complex signals of colour TV more seriously than simpler voice signals. As networks become longer, repeaters are needed to amplify and tidy up a signal before passing it on. Each repeater needs to derive its own clock. Often jitter created by one repeater is added to that created by others and the problem is magnified.

Jitter and related timing problems will lead to difficult choices in complex networks. If all the switching and transmission units in a digital network run in step, errors between clocks could wreak havoc. But if the elements operate asynchronously, expensive storage buffers would be needed to hold bits for processing.

The Post Office and STC recently completed an initial test of a 120 Mbit/s digital circuit between Guildford and Portsmouth. But more research on jitter and synchronisation will be needed before the Post Office takes the first steps towards an all-digital network in 1978.

## A radar to miss rainfall and hills

A detector that greatly improves the chances of airport radars distinguishing between aircraft and rainfall is being tested by the US Federal Aviation Authority. The new system will help air traffic controllers to track aircraft in bad weather, and in difficult terrain, accord-

## How to stop trains hitting cars

Microwave beams are being used in Japan to prevent trains and cars colliding on railway crossings. A system that has been installed on a crossing near Tokyo airport was recently described by Eikichi Yamashita of the Tokyo University of Electrocommunications at the Microwave 75 Conference in Hamburg. Some 500 electric trains and 50 000 cars cross each other's paths daily on the Tokyo airport crossing.

But a French engineer who also spoke at this month's Hamburg conference claimed that such systems were "not quite safe" because vehicles standing on the crossing might not be detected.

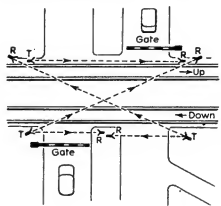
The Japanese technique is to transmit a set of microwave beams across the centre of the road. When the beam is interrupted by a vehicle after the barrier falls, trains are automatically stopped. But the problem with microwaves is that they don't

always travel in nice straight lines. Any metal surface could reflect or refract the beams, creating a sufficient signal at a receiver to keep the train running even if a car was blocking the direct beam. The Japanese group use a variety of pulse rates and polarisations to prevent these false signals being received, and report negligible interference. Yet Yamashita says that the success record was only "almost complete, after inspecting the record of operation." His cliffhanging remark (what happened to the other vehicles?) was not explained. However, the system was found not to have been degraded by dirt, and so on. And it is satisfactorily immune to dispersal by rainfall.

A French research team—led by Bernard Thoural at Toulouse—proposes the surface wave mode of propagation, where an electromagnetic field travels along the surface of the railway line. Any discontinuity in or near the line—such as a lump of metal above it, will produce an echo which can be used to trigger the alarm system.

But such systems are very difficult to use, says Professor D. N. Davis of University College London, who, as a BR research director, some years ago abandoned work on a similar project. Echoes from close range sparrows can look like distant three-ton trucks. In any case the exigencies of preventing traffic delay, mean that, in Britain at least, any such system is essentially useless. Vehicles will still be traversing the half-barrier crossing well after the train has passed its stopping distance. So no action can save a trapped vehicle. Almost uniquely in the British Rail system, Professor Davis said, level-crossing operation is "fundamentally a non fail-safe situation."

The Tokyo microwave installation for detecting cars on level crossings. R: receiver; T: transmitter



ing to *Aviation Week* (8 September, p 49).

The detector, developed by the US Lincoln Laboratory, solves two problems. The first is false alarms. Moving rainfall reflects radar signals. There is, therefore, a risk of confusing rain with aircraft. To eliminate this risk conventional radars only recognise as aircraft targets that produce radar returns above a certain threshold. But in heavy rain, this threshold may have to be set so high to filter out rainfall that the radar misses small aircraft.

The Lincoln unit measures the Doppler shift velocity of return pulses and classifies pulses according to their velocity. Most echoes from an aircraft will have the same Doppler-shift velocity. So will the return from moving rainfall. But the Lincoln system also measures the Doppler-shift velocity of returns from areas near the "object" of interest. If the target is in fact an aircraft, the number of nearby returns with the same Doppler-shift velocity as that of pulses from the target will be much lower. If the radar is looking at rainfall, the distinction will not be as sharp.

Another problem which the Lincoln system can handle is "blind-speed". Aircraft flying tangentially to the radar have zero radial velocity relative to the radar. They thus seem just like ground clutter—radar returns from hills and so on—to the radar. The Lincoln design solves this problem by dividing the area it looks at into over 350 000 cells and storing on magnetic disc a measure of the strength of clutter in each cell. This measure is updated with every scan of the radar. Any zero-velocity signal received is compared with the clutter level for the appropriate cell. Only if the signal is 4-5 times greater than the clutter value is an aircraft identified. This system will enable air traffic controllers to view a consistent track of an aircraft and not a series of broken lines that could be clutter and therefore ignored.

According to the Lincoln Laboratory, the parts for its new detector cost about \$22 000 and a production model should sell for less than \$70 000.

## Busy doing nothing

Much to the surprise of plant scientists at Leeds University, their experiments on spring barley sown in fields that have not been ploughed seem to show that not ploughing does not reduce the crop yield. A team in the department of Plant Sciences at Leeds, led by Dr Derek Hodgson, has been planting spring barley in unploughed fields for five years. They expected that unploughed soil would restrict the growth of roots and therefore cause gradually falling yields. But this has not happened—for reasons that have not yet been discovered but which the Leeds researchers speculate have something to do with the benefits that earthworms have on soil. Direct drilling saves on tractor fuel and is quicker—enabling farmers to take advantage of brief weather windows for planting. But spring crops were thought to be more sensitive to soil conditions and so the technique is not so common for these crops.



# Schools 'Win a Computer' Competition

jointly sponsored by Computer Weekly  
and Digital Equipment Company, Ltd.

The prize is a Classic (Classroom Interactive Computer) valued at £5,480\*—together with training in its use.

The competition is open to all schools in both the state and private sectors providing education for pupils between 11 and 18 years of age, in the U.K. The competition will take place in two stages. In the first, schools are invited to submit descriptions of a project involving a minicomputer which the school would like to implement. The five schools submitting the best entries will then go forward to the second stage in which they will be required to implement their projects up to the point at which the minicomputer could be used to provide results.

The five teams of finalists will be required to give a presentation and be questioned on their projects by a panel of judges comprising Dr. H. L. W. Jackson, Head of the Department of Computing, North Staffordshire Polytechnic; Mr. J. J. Turnbull, Head of Educational Application, National Computer Centre; and Mr. W. R. Broderick, Head of Educational Computer Centre, London Borough of Havering.

To obtain a copy of the rules and entry form please complete the accompanying coupon and return it to Computer Weekly, Room 118F, Dorset House, Stamford Street, London SE1 9LU.

\*Special price for educational institutions.

I am interested in entering the schools 'Win a Computer' Competition. Please send me a copy of the Rules.

NAME  
(BLOCK CAPITALS)  
SCHOOL

ADDRESS



## Chromium pollution hits Japan

The drive to clean up Japan seems merely to be unearthing evidence that the damage done in the past is worse than previously imagined. The latest skeleton in the cupboard is hexavalent chromium. News of a high incidence of lung cancer among workers in chromium processing plants, following the discovery that the highly toxic chemical is polluting large areas of reclaimed land, is causing extreme concern bordering on panic, a not unexpected reaction in a country that has already witnessed the horrors of cadmium and mercury poisoning.

In August, residents of a low-lying part of Tokyo noticed yellow water seeping out of the ground. It was later found to contain 100 ppm of hexavalent chromium (the legal limit in drinking water is 0.5 ppm). Demands to trace the source of the chromium led to the discovery that

the local authorities had known for some time that the Nippon Chemical Co had dumped 527 000 tons of hexavalent chromium-polluted slag at 34 sites in or around Tokyo between 1938 and 1971 (when a law controlling the dumping of industrial wastes came into force), yet had done nothing about it.

During the investigation, Nippon Chemical admitted that it had concealed information from the Labour Standards Office about the deaths, from lung cancer, of eight workers engaged in the production of bichromate soda from chromium ore.

This prompted a team from the Hokkaido University Department of Medicine to check workers at the Nippon Denko Kuriyama plant. They surveyed all employees who had worked there for more than nine years and found 19 cases of



lung cancer (14 fatal)—a death rate 26.5 times greater than the national average. The same company has also dumped 220 000 tons of slag at various sites, including the playing fields of the local primary school. Nippon Denko claimed that it had dumped the slag at the request of local building contractors who found it helped to solidify the ground and kill weeds. The Hokkaido Prefectural Government decided to give an immediate medical examination to every member of the population of Kuriyama.

In Tokyo, arguments began over who had to pay to clean up the mess. Local governments are anxious to set a precedent for the "polluter pays" principle, but Nippon Chemical claimed it does not have the financial resources to clear the slag. It said it would try to neutralise the slag, but the cost of doing this properly (20 000 yen—£35—per ton) was too much. The Metropolitan Government envisages concreting over all polluted areas. The total cost of the clean-up in Tokyo is estimated at 1000 million yen (£1.5 million) over the next three years.

The Ministry of International Trade and Industry (MITI) launched a nationwide survey of chromate pollution. If this was designed to bring reassurance, hopes were certainly dashed. Other firms (including Asahi Glass Co and Mitsui Metal) and other sites were found to be involved in the dumping of hexavalent chromium slag in residential areas. Further evidence that the metal was affecting humans came from Tokushima where the urine of employees of Nippon Denko and local residents was found to contain twice as much hexavalent chromium as that of people living a long distance from the plant. Chromium dust was blamed in this case.

Meanwhile a news agency carried out its own survey and found that 41 people have died from diseases related to hexavalent chromium while 232 persons are suffering from perforation of the nasal septum, known to be an occupational disease in the chromium industry. It also found that hexavalent chromium poisoning extends into other industries, such as plating, leather, and dye works, where chrome compounds are used.

Many of these revelations are the result of the formation of the Council of Hexavalent Chromium Pollution Victims, an organisation set up to fight for adequate compensation.

John Fairbairn

### ... and clearing up profitably

A small Macclesfield engineering company this week launches an effluent treatment process that could save industrialists a small fortune. Most companies see effluent treatment as a bite out of their profits. But the new process, developed by Ecological Engineering Ltd, reclaims useful metals from effluent and therefore allows the operator to at least recoup the capital cost of the treatment equipment.

The process is an electrochemical one for non-ferrous metals—gold, silver, copper, zinc, lead, nickel, tin, cadmium, and chromium. A portable commercial-sized module has been built with the backing of the National Research Development Corporation (NRDC) to demonstrate the process to potential customers. NRDC forked out £100 000 to finance the development of the process on a 70-30 basis, not its usual 50-50. Obviously NRDC has considerable faith in its potential.

The equipment involved is a cylinder about a metre long and almost a metre in diameter with associated feed tanks and so on. In the cylinder is a cathode in the shape of a rotating central drum. Anodes are fitted to the walls of the cell. Metal-contaminated waste is fed continuously through the field created by anodes and cathode. Metal is deposited as a powder on the rotating cathode. Gas and liquid by-

products are separated from the metal further downstream.

Effluents containing more than one useful metal can be handled by passing them through a bank of cells in series. According to Terry Kavanagh, sales manager of Ecological Engineering, there are no problems of contaminants in the waste fouling the process. But complex reactions between organic compounds in the effluent could create toxic materials. This, says Kavanagh, will have to be looked at when a plant is actually running.

Kavanagh says the economics of the process are very promising. The mobile unit built with NRDC backing is a 2000 amp unit capable of recovering some 18 tonnes/year. It would cost about £25 000. The current price of metals such as copper means that the capital cost of this system could be recovered in about three years. Kavanagh quotes the case of a Danish company presently discharging effluent containing copper into local water courses. The company has been told that it cannot discharge effluents with more than 0.2 parts per million of copper. It can meet this standard economically only with Ecological Engineering's equipment, which will give it about 100 tonnes of copper a year to feed into its dyestuffs plant.

Markets for the Eco-cell, as the system is called, are to be found in all metal-using industries, particularly dyestuffs, plating, galvanising, and printed circuit board manufacture.





### A tricycle made for one

A tricycle for a four-year old boy with spina bifida has been designed by two schoolkids from Didcot. With the help of two teachers, the two kids have developed a bike that overcomes the disadvantages of machines available on the National Health Service (NHS).

James Mitchell is paralysed from the waist down. A teacher who knew the boy challenged the senior boys at St Birinus' School in Didcot to design and build a machine that would allow James to move around. The machine had to be cheap, allow for James's growth, and give him some exercise. It also had to protect his legs which are susceptible to blistering.

James had already tried the two mobility aids recommended through the NHS. One, a four-wheeled battery kart, allowed James no scope for exercise and did not have enough power to take him over obstacles such as kerbs. The other, hand powered by levers linked to the wheels by cranks, was too heavy.

Jeremy Stroud and Peter Evans, the two schoolkids, originally intended to build a machine from scratch. But a visit to the Cycle Supermarket in Reading, where bicycles are converted into racing



Right on for James Mitchell

bicycles, convinced them that it would be easier to convert an existing tricycle for James. Further, this would make maintenance easier since standard parts would be used.

The tricycle they have now built is powered by "pedals" which are simple extensions of the handlebars. The "swing" of the crank was tailored to fit James's reach. A standard adult cycle rear hub was fitted to the front wheel and the forks spread to make room for the chain drive mechanism. The seat of the bike

was a standard model that normally fixes on to the back of an adult bike to carry a child. Both seat and handlebars can be adjusted for height so the bike will grow with James. The bike also has sheet steel leg guards because James has no control over his legs which would otherwise splay outwards. Ordinary caliper brakes are operated by shoulder straps—the brake comes on when James hunches both shoulders forwards, but not when he pushes a single shoulder forward (*School Technology*, September).

### Robots march into Europe

"The market in Europe for industrial robots is not meeting the resistance that has deterred growth in the US". So says a survey of the market for industrial robots (Frost & Sullivan, London, £210). The European market for computer-controlled, advanced industrial robots is estimated in the survey as £2200 million in 1985. Because wages in the UK are relatively low, the major areas of growth are expected to be in Germany, France, and Italy. In 1980 a mini-computer controlled robot should cost £2.44 an hour—less than the projected hourly wage of £2.80 with added fringe benefits.

To distinguish them from automatic machines, current industrial "robots" are defined as programmable, memory-controlled machines with several degrees of freedom of movement. The next stage in the development of these robots will be, according to Frost & Sullivan, the introduction of sensory-controlled devices capable of "make and test" routines. Next will come machines that can perform the equivalent of coordinated eye-hand motions and then on to a generation with a modicum of factory intelligence, to handle the assembly of discrete parts.



The UK has been much slower than some European countries in accepting sophisticated programmable machines. Sweden leads with 26.2 per cent of installations, followed by Italy (21.3 per cent), Germany (with 14.3 per cent) and then Britain (almost 10 per cent).

The Frost & Sullivan report says that further research is needed to develop machines that can:—

- sense the workstation environment and process sensed data;
- integrate these data with manufacturing data and make judgements;
- learn and modify perception and response;
- develop concepts, assign meanings to representations of workstation environments; and
- develop rules, self-schedule, and select new sequences of manipulation.

### Jaguar breaks motorway speed limits



One of the Jaguar aircraft's more astonishing facets was demonstrated recently on the southbound carriageway of the new M55 motorway. The M55, between Blackpool and Preston, runs straight and level for some 800 metres, free from bridges and overhead wires. Taking advantage of this unusual motorway geography, Tim Ferguson, BAC's chief military test pilot, landed a Jaguar in about 400 metres of the M55.

Avoiding arrest for carrying out a U-turn, he ran back up the motorway to nestle under a bridge while his Jaguar was refuelled and loaded with 4000 lbs of bombs. He then took off in less than 600 metres.

All this unusual activity has a serious side. Soon the 200th Jaguar will roll off the production line. Strike Command will take 60 of the 200 ordered for the RAF and form two squadrons based in East Anglia. But air bases are highly vulnerable targets. German and Swedish air forces have, for some time, planned to disperse their aircraft to operate from sections of motorway if necessary. And soon defence ministries will be testing Jaguar's ability to land on grass strips and other rough surfaces—an ability written into Jaguar's design specifications by NATO customers. So there is little doubt that the RAF could operate Jaguars from motorways. Hence the M55 demonstration.

Road experts say that there is "quite a number" of motorway sections on which Jaguars could land, particularly on the M1. But the RAF says it has no plans to carry out peacetime exercises on motorways. So there is no danger of a Jaguar landing on the roof next time you drive along the M1.

## A battery of battery vans

Lucas is all set to announce a new battery driven vehicle at the Paris Motor Show beginning in October. This follows the company's recent placing of one-tonne Bedford vans converted to run on lead-acid batteries on trial with British fleet operators. The vans are phase two of Lucas's work on lead-acid battery vehicles (it has ruled out zinc/air cells in the short term). So far details of the vehicle to be revealed at Paris (phase three) are scanty—but it is not a van, bus, or taxi, yet is designed for city centre operation.

Ten of the Lucas vans have been taken by the Post Office—for mail collections in London and for telephone engineers in the Stevenage area. The trial will run for three years to assess the Lucas drive system, performance, and costs. Lucas has already introduced a 34-seater battery bus to Manchester.

The converted Bedford vans can travel at speeds over 50 miles/hr driven by 216 volt motors producing 50 brake horse power. The drive is to the rear wheels through a propeller shaft and conventional back axle. There is no gearbox—the driver has two buttons on the fascia—one for forward travel and the other for reverse. The control system developed by Lucas is a solid state chopper which operates by interrupting the power



Lucas's battery-powered Bedford vans

source many times a second. By altering the ratio of open to closed times, the average voltage across the motor is adjusted.

The batteries chosen by Lucas are polypropylene SLI (starting, lighting and ignition) lead-acid cells. They can be placed in a rapidly-interchangeable pack transversely across the vehicle, or arranged in longitudinal panniers so that the driver can walk through the van. Lucas has also designed a regenerative braking system that uses the kinetic energy of the vehicle when braking to drive the traction motor.

Meanwhile Gould Inc. is, according to the US newsletter *Moneysworth*, developing a hybrid power unit. A two-cylinder petrol engine powers a generator which in turn charges the drive batteries. According to Dr Edward Davis of Gould, this overcomes restrictions of overnight charging and limited range. Petrol consumption is between 50 and 70 miles/gallon. Steep hills, however, create a problem because the petrol engine has a constant output and therefore the extra power needed for hill-climbing must come from the batteries.

## Shifting static

Static is the Hi-Fi addict's sworn enemy. Cleaning a record inevitably creates static on the disc which attracts dust, making the record dirty again. The latest anti-static device, soon to be marketed by EMI, is a carbon fibre mat.

The mat lies between the record and turntable. As long as the central spindle of the turntable is earthed (as it is on most record players), the negative static charge on the disc induces a positive charge in the mat. Overall, electrical neutrality is maintained and so dust is not attracted to the record. When the record is removed from the turntable, the mat returns to its original state ready to neutralise the next disc.

# new Scientist

# Scientific Equipment

**No. 1**

**BINOCULARS**  
Russian, Zeiss, Habicht, etc.,  
UP TO 40% DISCOUNT

**FILMS AND SLIDES**  
OF AMERICAN SPACE  
MISSIONS

**250 BOOKS ON  
ASTRONOMY**

send large SAE for free mail  
order catalogue to:—

**ASTRO BOOKS AND SUPPLIES**  
342, Lower Addiscombe Rd.,  
Croydon CRO 7AF

**No. 2**

**BIOFEEDBACK  
INSTRUMENTS**

feed back signals related to physiological processes, for research or learning greater control of Self.

**MYOPHORE** for muscle activity

**TELEPHONE** for blood flow control

**RELAXOMETER** for arousal/relaxation

**ALPHA SENSOR** for brain electrical activity

for brochure and details of technical books

**ALPHA ONE LTD., PO Box 725  
CAMBRIDGE Tel 811679**

**No. 3**

**CALCULATORS**  
TOP NAMES—BIG SAVINGS!!!

SINCLAIR	CEN	THOMSON	C7 95
Calculator	£12.95	360A	£10.95
Calculator	£11.95	360B	£10.95
*Calculator	£24.95	360C	£10.95
Calculator	£24.95	360D	£10.95
Calculator	£24.95	360E	£10.95
Calculator	£24.95	360F	£10.95
Calculator	£24.95	360G	£10.95
Calculator	£24.95	360H	£10.95
Calculator	£24.95	360I	£10.95
Calculator	£24.95	360J	£10.95
Calculator	£24.95	360K	£10.95
Calculator	£24.95	360L	£10.95
Calculator	£24.95	360M	£10.95
Calculator	£24.95	360N	£10.95
Calculator	£24.95	360O	£10.95
Calculator	£24.95	360P	£10.95
Calculator	£24.95	360Q	£10.95
Calculator	£24.95	360R	£10.95
Calculator	£24.95	360S	£10.95
Calculator	£24.95	360T	£10.95
Calculator	£24.95	360U	£10.95
Calculator	£24.95	360V	£10.95
Calculator	£24.95	360W	£10.95
Calculator	£24.95	360X	£10.95
Calculator	£24.95	360Y	£10.95
Calculator	£24.95	360Z	£10.95

\*Full FREE Short Price Analysis  
price includes 8% VAT. All models include  
1 yr. full guarantee. Add 25p P & P.  
Southern Region: cash orders only.  
Tel: 01-442 4190  
Fax: 01-442 4190  
24 Alphonse Street, Sutton, Surrey

**LANDAU RADIO LTD (Dept. NS3)**  
195 HIGH STREET, SUTTON, SURREY

**No. 4**

**Transpalite\* Acrylic**

25 years of experience in the specialised manufacturing and machining of acrylic materials.

One off or in quantity.

Any problem we will solve them for you!

Seamless acrylic tubes, rods and blocks from 2" to 20" in diameter

**Stanley Plastics Limited**  
HAMBROOK - CHICHESTER - SUSSEX  
Tel: West Ashling SS12 \*Regd. Trade Mark

**No. 5**

**NIM modules, MCA's  
N30 Series Pulse  
height analysers**

● Integral HV supply  
● Single cable to detector  
● HV scan for automatic  
detector characteristic  
plots ● Pile-up control  
amplifier ● Wide-range,  
non-overloading amplifier  
● Auto plot facility for  
gamma spectra.

Our full colour short  
form leaflet gives full  
information on our range  
of nuclear instrumentation.

■ brandenburg ■

**NUCLEAR**  
939 London Road, Thornton Heath,  
Surrey CR4 6JE Tel: 01 689 0441

**No. 6**

**ZWITTERIONIC  
BUFFER  
KIT**

different buffers in a convenient kit to help you decide the best biological buffer for your system; pKa's range between 6.8

U.K. PRICE **£10.50** + VAT

**HOPKIN & WILLIAMS**  
P.O. Box 1, Romford RM1 1HA : 01-509 7700

**No. 7**

**High current.  
Low cost.  
Laboratory power supplies.**

**Instead ELECTRONICS**  
Rushley Road, London N15 5JB (01-4025144)

**No. 8**

**SCHUCO MINIPUMPS**

Inexpensive peristaltic pumps—mains operated. Flow rates from 0.2 to 25 cc. per minute.

Size 2½ x 2½ x 1½".

Prices £7.25 to £8.75

Details from:  
**Schuco Scientific Ltd.,  
Woodhouse Road,  
London, N.12.  
01-368-1642**



# Energy file

Michael Kenward

## Conservation

### A new force

Britain's energy conservation programme has been a failure, according to the House of Commons Select Committee on Science and Technology. According to the Committee's latest report: "Apart from a weakness in central direction the Government machine lacks any local organisation to achieve effective saving in industry, in particular among the smaller and medium sized firms."

The committee recommends the creation of an energy conservation "task force" which would include "Ministers, officials and a few outside experts (eg from industry, including the oil companies and fuel economists)". A key part of any energy conservation programme would be "a clear target to aim at, such as 15 per cent saving within two or three years". The MPs are not seeking a new organisation merely for the sake of doing so: "New government machinery will not, of itself, save a single barrel of oil; but effective conservation policies are unlikely to emerge without an appropriate machinery for developing and implementing them."

The report is careful to define what it means by energy conservation. "The aim of energy conservation should be to eliminate energy waste without reducing real living standards and without incurring capital and labour costs greater than the value of the energy savings."

Research and development is not, says the report, likely to do much for short-term energy conservation. "No quick results can be hoped for from new sources of energy . . . This does not mean that the search for new sources is unimportant or that R & D in the most important areas should be neglected or decisions on projects and spending delayed. But we must not expect too much too soon."

The new task force would take over the role of the Advisory Council on Research and Development for Fuel and Power (ACORD). "Despite its wide terms of reference ACORD has traditionally been used solely to review and coordinate the R & D of the nationalised energy industries. It is hard to see how it came to occupy this position for which it does not seem to be particularly well equipped." The report questions whether Walter Marshall, the chief scientist at the Department of Energy, was being realistic when he told the committee that he wanted to widen ACORD's coverage. "We wonder whether a body selected according to the narrow task Ministers have expected

from them up to now, is capable of such adaptation, especially as the fuel industry members must have an interest in defending their own R & D programme from scrutiny and interference by the government and competing industries."

*First Report from the Select Committee on Science and Technology, Energy Conservation. House of Commons Paper 481, HMSO, 95p.*

### Independent advice

One of the Select Committee's recommendations was that "a 'taskforce' of Ministers, officials and a few outside experts (eg from industry, including the oil companies and fuel economists) should be set up". This taskforce should "absorb and replace the Advisory Council on Energy Conservation" (ACEC). By coincidence, the Select Committee's report was published a week after the ACEC's *Report to the Secretary of State for Energy*. (Energy Paper Number 3, HMSO, 80p.)

This short ACEC report—there are four pages of recommendations, following a two-page introduction—emphasises the importance of government guidance on energy policy as a key to energy conservation. In particular, the question of energy prices dominates conservation. "We regard the setting of correct prices as an essential pre-requisite to energy conservation", says the ACEC. This already is an accepted part of government policy, indeed Eric Varley said as much before he created ACEC. However, the government has been less clear on other aspects of energy pricing.

ACEC recommends that "the Department of Energy should study the question of the balance between the prices of the various fuels in the light of the sharp rise that has taken place in oil prices." Even if there are no subsidies on energy, and each of the energy industries operates commercially, there will be different prices for different fuels. At the moment, for example, the CEBG can buy coal for power stations below the cost of fuel oil. And gas is cheaper than other fuels on a price per therm basis.

The ACEC wants the government to look at the idea of thermal equivalent pricing—which could mean adjusting the price of gas so that the cost of a therm of energy obtained from gas matched the cost of a therm of energy by burning oil. This is a complex issue, which fuel, for example, should be the baseline fuel? Oil is an important drain on Britain's balance of payments at the moment; but what happens when the UK becomes self-sufficient in oil?

The energy man's "holy grail"—a forward looking government energy policy—rears its head in the ACEC report: "It is essential . . . to future planning for industry to have the best Government guidance that can be made available as to energy policy intentions particularly regarding the availability of supply and pricing."

As well as these more general points—most of which have been knocking around the energy scene for some time—the ACEC report contains some specific recommendations. It says: "Companies should be encouraged to record for their own benefit energy use by source, total energy per unit of product, per unit of raw material or by value of sales." Such a record might form the basis of an "energy impact statement". The report suggests that such a statement "should be required from any industry receiving government financial assistance for submission to the Department of Energy".

On a more concrete level, the report advocates "preferential mortgage treatment for buildings of a higher standard". And the government should examine "ways of encouraging economy in the domestic use of hot water through for example extended installation of showers rather than baths and the marketing of cold water detergents". On the transport scene: "Government should take steps to encourage the manufacture of cars which are economical in energy terms. This might be effected by placing design and development contracts or by various forms of fiscal incentives."

### International affairs

Another Select Committee has been looking at the EEC's proposed energy policy strategy. The 22nd report from the Select Committee of the House of Lords on *The European Communities* says: "The Committee believe that the Commission has not succeeded in making the case for an interventionist policy".

The committee wants the EEC to stick to "certain activities which might produce some increased degree of self-sufficiency and some mitigation of the likely long-term resource shortage", such as R & D and energy conservation. In particular, the report underlines the importance of "identifying further recoverable resources of coal, hydrocarbons and nuclear fuel raw materials" and of improving their yield.

Alex Eadie, a junior minister at the Department of Energy, recently said that the EEC energy R & D programme "includes eight specifically identified sectors concerned with energy conservation including: insulation of buildings, heat pumps, residual heat recovery, improvements in industrial energy use, and development of methods for the storage of secondary energy." Almost £5 million has been earmarked for the four-year energy R & D conservation programme. "The work will be done under contract and participating organisations will normally be expected to make a contribution to supplement that from the Commission." According to Eadie, this represents "a considerable opportunity for British research organisations and firms who believe they have something positive to contribute."



## Garbage

### Slow recovery

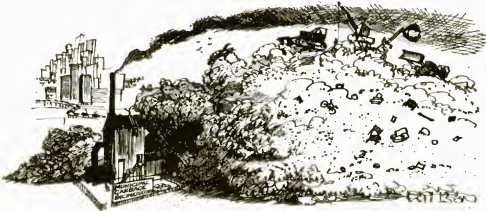
Around 0.4 per cent of the fuel consumed by electricity utilities in the United States in 1980 could be municipal solid wastes (MSW) if all of the projects now at various stages of advancement are realised. This programme would convert a total of 44 000 tons of MSW a day into an "equivalent power" of just over a thousand megawatts. A recent report prepared by the Bechtel Corporation, San Francisco, for the Electric Power Research Institute, lists the US's activity on reclaiming energy from municipal refuse. In all, just over 1000 MW of generating capacity, fed by 44 000 tonnes of garbage a day, is at various stages of development.

According to the report: "If all the MSW available in collected form in urban areas were to be utilised, it could supply about 6 to 7 per cent of [electricity utility] fuel needs. Thus, the currently known projects represent approximately 1/15 of those possible." The EPRI report discusses six different ways of recovering energy from MSW (see table).

Garbage can provide energy but, as Dr Andrew Porteous points out in the latest issue of *Resources Policy* (vol 1, p 284), "the object of the exercise from the local authority view point is to dispose of the refuse at the lowest possible cost". And straightforward incineration with no energy recovery (which reduces the volume of the material that has to be disposed of by something like 90 per cent) is the simplest way of disposing of garbage. "Recuperative incineration, or any other recycling process, must make its case on the disposal cost per tonne of refuse input and indirect recycling or energy recovery must be viewed as an operation that has to reduce disposal costs as opposed to 'straight' or non-recuperative incineration." Porteous concludes that "the financial incentives for power generation from refuse are not great unless energy revenues increase."

Pyrolysis—which involves heating refuse to a temperature between 500 and 1000°C in the absence of air—can produce a combustible gas. This technique is available commercially. However, Porteous points out that "in the UK context the calorific value of the gas is half that of North Sea gas, this may pose severe marketing problems." The selling price of pyrolysis gas clearly "has a marked effect on the economics" of this technique, and "unless its installed cost is competitive with incineration and there is a market for the product there is currently little incentive for its adoption in the UK".

Energy-from-waste is one of the topics being considered as a part of the energy R&D programme that the International Energy Agency (IEA) is assembling. The IEA has given the



"For God's sake shovel a bit faster Bert . . . they're gaining on us."

responsibility for this topic to The Netherlands (see Energy file, *New Scientist*, vol 65, p 214).

The IEA is preparing a report on energy from waste, and Britain's Warren Spring Laboratory (WSL) is providing a section on existing projects and R&D under way in the UK. It seems that waste utilisation is more popular in Germany and Switzerland than the UK. Warren Spring, however, is planning to build demonstration

plants for its pyrolysis and waste sorting projects. Each plant could cost between £2.1 million to build. At the moment WSL is operating a prototype sorting plant that can handle 3 tonnes an hour, the demo plant would be able to handle 200 to 300 tonnes a day. Britons generate 18 million tonnes of domestic refuse each year. WSL estimates that all "municipal" waste could meet 2.2 per cent of UK energy consumption.

#### POSITIVE ASPECTS

- ★ Has gained acceptance by manufacturers
- ★ Existing facilities can be used to generate steam for electricity
- ★ Healthy competitive business
- ★ Highest overall system efficiency
- ★ Relatively low costs
- ★ Revenues from recovered materials

- ★ Produces a medium-Btu fuel gas
- ★ No feed preparation required
- ★ Existing power plants can be used
- ★ Large-size demonstration project under way
- ★ Relatively high overall system efficiency
- ★ Fuel gas usable in all type boilers

- ★ Final product is easily transported and stored
- ★ Existing power plant can be used
- ★ Large-size demonstration plant under construction
- ★ Revenues from recovered materials

#### Anaerobic digestion of landfilled MSW to methane

- ★ Final product can be used in boiler with minor modifications
- ★ Good overall system efficiency
- ★ Eliminates odour and gas migration problems from land fills
- ★ Low costs
- ★ Purified final product gas is similar to natural gas

#### Combustion/electric power generation

- ★ Total electric power production package
- ★ Good overall system efficiency
- ★ Smaller-size system than incinerator or power plant
- ★ Revenues from material recovery
- ★ Serious technical problems with gas cleanup system before gas turbine
- ★ New electrical generation equipment required
- ★ Relatively high costs
- ★ Not demonstrated on large scale

#### Incineration with heat recovery

- ★ Good method for use in district heating
- ★ Higher burnout efficiencies can be expected versus incineration of unprepared refuse
- ★ A dry bottom ash system is used
- ★ Commercially available
- ★ Corrosion of boiler tubes occurs at high steam temperature
- ★ Involves commitment to dispose of refuse
- ★ Steam flow not dependable enough to run power plant auxiliary systems
- ★ New Electrical generation equipment required
- ★ High costs

#### NEGATIVE ASPECTS

- ★ Low bulk density of fuel product makes storage difficult
- ★ Potential increase in particulate loading
- ★ Difficulties with equipment wear in pelletising and briquetting operations
- ★ Uncertainty in applicable air emission standards

#### Pyrolysis to a fuel gas

- ★ Ability to handle shredded MSW has yet to be proved
- ★ No metals are reclaimed
- ★ Potential plugging of slag
- ★ Fuel gas not compatible with natural gas distribution network
- ★ Storage of fuel not feasible
- ★ Relatively high costs
- ★ Large-scale test of fuel gas in boilers not yet started

#### Pyrolysis to a fuel oil

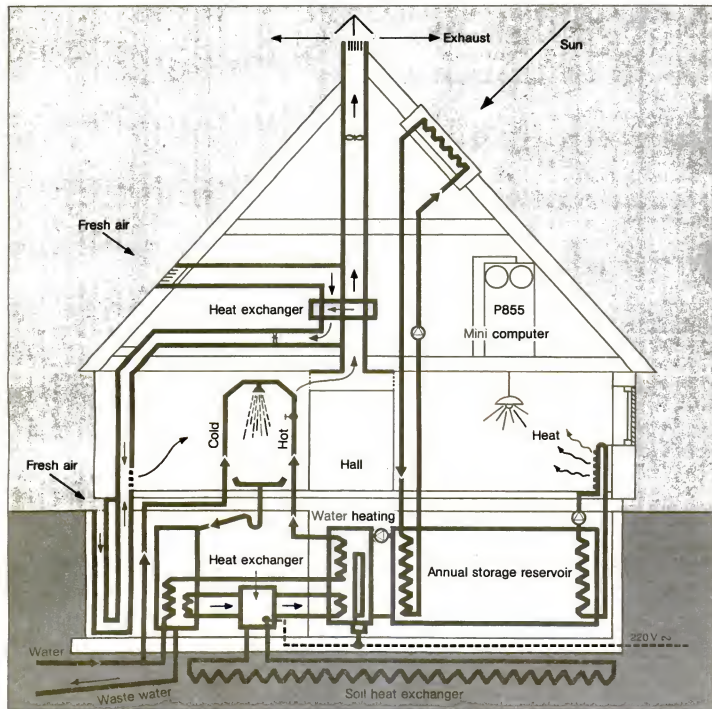
- ★ Questions have arisen about corrosive nature of the fuel oil
- ★ Relatively high costs
- ★ Large scale tests of oil in boilers not yet started

# Energy conservation in practice

Discovering new energy sources is not the complete answer to our future energy needs. We must also discover ways to conserve energy and to use it more efficiently. To study methods of energy conservation under practical conditions, Philips, in cooperation with RWE, Essen, and the German Federal Ministry for Research and technology, have built an experimental

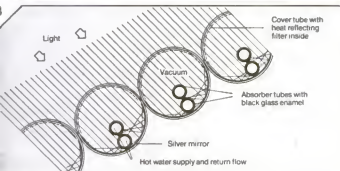
house in the grounds of the Philips Research Laboratories in Aachen.

The energy consumption requirements of an average family of four are simulated by two Philips computers, which also control the heating system and process the data measured. A normal electricity supply is used for lighting, cooking and the usual appliances, however, energy for all





household heating - totalling some 6300 kWh per year - is supplied by the sun. For example, incident solar energy striking a solar collector battery in the roof is converted into low-temperature heat (up to 95°C) and stored in an annual storage reservoir in the cellar. Solar energy absorbed at the earth's surface (soil heat) is also used for heating as well as for cooling



The living area of the experimental house is completely equipped with all the furniture and technical appliances for a family of four. Apart from the solar circuit, systems being tested include heat pumps, used for example, to extract heat from the ground under the house, the heat exchangers which recycle the warmth from outgoing waste water and stale air, and an air intake heating/cooling system. The annual heating energy requirement for heat conduction losses is 6300 kWh and 2000 kWh for ventilation losses.

during the summer months. Heating energy requirements have been reduced to a minimum by the use of improved building insulation techniques and a unique type of double-glazing developed by Philips. Brief details on some of the technology used is given below.

**2 The solar collector battery** of 20 m<sup>2</sup> has been installed in the south-side of the attic roof and inclined at an angle of 48°. The battery consists of 18 solar collector boxes, each box housing 18 evacuated glass tubes containing the actual collector elements. In developing the solar collector Philips applied their extensive knowledge of heat reflecting layers in low pressure sodium lamps; the layers also being used in the collector to obtain a high degree of efficiency even with low solar radiation intensities. On average, the solar battery will collect about 10,000 to 12,000 kWh hours of energy a year.

**3 Each solar collector** possesses a heat reflection filter made of indium oxide (In<sub>2</sub>O<sub>3</sub>) having a sunlight transmission  $T = 85\%$  and a reflection  $R = 90\%$  for heat radiation. The absorber has an absorption factor of  $\alpha = 95\%$  for sunlight. Compared to a flat collector with selective absorber ( $\alpha = 0.90\%$ ,  $\epsilon = 0.10$ ) and double-glass covering, the Philips collector with additional covering is considerably more efficient and was specially developed for Central European latitudes. In the following table the values were found empirically for the application for heating water in summer (water temperature 50°C above outside temperature).

Conditions	Overall radiation W/m <sup>2</sup>	Flat collector = %	Philips collector = %
Cloudless sky/clear	800	53	61
Slightly cloudy/hazy	600	46	58
Light overcast	300	17	45
Heavy overcast	150	0	20

If you would like to receive more information on this experiment, please mail the coupon, or write to Philips Industries, GAD-EMB-2/room 16, Eindhoven, Holland

Send me more information on the solar energy experiment

Name:

Position:

Country/City:

Address:

Zipcode:

Post to: Philips Industries, GAD-EMB-2/room 16,  
Eindhoven, Holland. PLEASE WRITE IN CAPITALS.

33-15

**PHILIPS**

working on energy conservation



# Feedback

## UGC, DES criticised by MPs

The Department of Education and Science and the University Grants Committee were criticised last week for failing to recognise the difference between universities and the rest of the education system, particularly insofar as this difference involves scientific research. The criticism came in the first report from the science sub-committee of the Select Committee on Science and Technology, which is looking into scientific research in British universities (House of Commons Paper 504, HMSO). At the same time, the committee recommended that universities should review their own research priorities, and that the provision of financial aid to postgraduate students should be rationalised.

The science sub-committee has been looking into research in British universities since the end of last year, and its enquiries are still in progress. At present, members are in North America, obtaining information about the universities' role in the research system there, as they have already done in France and Germany.

The document, published last week, is an interim report concerned mainly with the "widespread concern about the short-term future of the scientific research effort of the universities, resulting in particular from the erosion of university funds through inflation". It contains seven suggestions which, the sub-committee believes, should "ensure that the present financial shortages do not continue to hit the research activities of the universities in an indiscriminate and arbitrary manner".

The DES and the UGC should, the committee suggests, acknowledge the importance of both the teaching and the research activities of the universities. In its opinion, "the intentions of Parliament in voting money to [the UGC] to distribute to the universities 'as centres of advanced education and research' . . . are not being satisfied" because financial shortages are being "allowed to fall disproportionately and indiscriminately on the research activities of the universities".

If their activities have to be reduced, both universities and UGC should ensure that research is not "arbitrarily sacrificed in order to maintain a preordained level of student numbers" and "the Department of Education and Science should not expect, and the universities should not accept, growth targets for student numbers which, unless there is a sudden improvement in the economic situation, could only be achieved at the expense of the universities' research activities". If real reductions in the level of university activity are considered necessary, the committee continues, they should be "accompanied by as strong a guarantee as possible that the reduced level of activity will be maintained".

At the same time, the committee calls on the research councils to review their priorities "to ensure that maximum pos-

sible support and encouragement is given to those areas of research which they consider to be of greatest promise and to be in the national need" and, if the UGC "floor" of research support continues to subsidise "the research councils should adopt as flexible an attitude as possible towards the indirect support of that floor from their own funds, particularly in new and interdisciplinary areas where



## Dutch government cuts brain research

The Dutch government is to close the Netherlands Central Institute for Brain Research in Amsterdam as part of a package of economies. According to a spokesman for the Institute, the closure represents almost a 50 per cent reduction in fundamental neurobiological research in the country.

The announcement that the Institute's long history was to be brought to an end came out of the blue. Professor Hans Kuypers, who was to have taken over as director later this year complained that "little consultation has taken place". As the decision was taken by the Dutch cabinet, there seems little hope of reversing it. However, on 15 October the Standing Committee on Science Policy is to discuss the proposed closure, and will consider a lengthy memorandum presented collectively by the staff of the Institute.

Since its inception in 1908 the Institute has established a firm place for itself in the science of neurobiology. One of its major characteristics is the interdisciplinary flavour of the research—something which does not occur elsewhere in Holland.

The current director, Professor Johannes Ariens Kappers, is probably best known for his research on the function of the pineal gland, a structure that is important in regulating daily rhythms. Professor Kuypers, who was to have moved to the Institute from Erasmus University, Rotterdam, would have swung research emphasis to the study of animal behaviour. He is particularly interested in hand/eye coordination.

Kuypers was offered the directorship last year. He was very anxious to accept, but wanted an assurance that the long-promised building would be provided within a reasonable time—say, five years.

the 'floor' has not yet been established. For their part, it is suggested that "the universities should review their own research priorities and explore the possibilities of interdepartmental sharing of resources and manpower in order to avoid the uniform dilution of research effort."

On the question of postgraduate students in science, the committee recommends differential grants to "provide the research councils with a practical and valuable tool to assist in the encouragement of research in priority areas". It also feels that "the SRC should actively encourage the 'topping up' of postgraduate studentships from industrial and other private sources".

With respect to postgraduate students from overseas the committee has "yet to be convinced that in order to be certain that deserving overseas students are not penalised the academic fees charged to overseas students should remain at what is admitted to be a notional level," and supports the Expenditure Committee's recommendation—made in 1973—that such fees be raised to a sum that fully covers costs, and at the same time a proper aid programme of scholarships for poor countries be instituted.

Currently the Institute is housed in unsuitable accommodation in an inaccessible part of the city. Instead of that assurance, Kuypers, along with the trustees of the Institute, was informed on 15 August that not only was the 12 million guilders needed for the building not to be forthcoming, but that the Institute was to be closed altogether. Kuypers and the trustees were sworn to silence until 27 August when a deputation from the Ministry of Science and Education visited the Institute to tell the rest of the staff.

Currently the Institute has room for 35 post-doctoral researchers, plus postgraduate students and technicians. The government has made noises about relocating these people, but Dr M. A. Corner of the Institute told *New Scientist* that "it is very difficult to see where their people will go". The plan at the moment is to bring the Institute finally to a close in December 1976, with a steady reduction proceeding until then.

Professor Kappers has said that "We of the staff feel that such a drastic move is out of all proportion both to the savings which can reasonably be expected (the current budget is four million guilders a year) and to the damage inflicted upon neuroscience research in this country". Kappers has agreed to stay on as director until December 1976 rather than retiring this year as originally planned.

Meanwhile, Kappers and the rest of his staff hope the Institute may be saved. There is certain to be strong protest, and not just from Holland. For instance, *New Scientist* has been told that the Brain Research Association in Britain is to make a formal protest. Protests from other British organisations are also expected to follow.

Roger Lewin

## Fission over laser fusion project

The year-long struggle to establish a high-power laser facility in Britain is coming to a climax. But the shape of the final project will almost certainly be very different from that first envisaged. Initially, the Science Research Council (SRC) and the UK Atomic Energy Authority (AEA) put forward a proposal for a joint project, costing something like £2 million a year to operate (see Energy file, *New Scientist*, vol 63, p 76). Following Treasury rejection of the AEA's request for £1 million for capital expenditure on the new facility, the Authority has had to drop out.

As a result, there will now be less emphasis on laser fusion research. Instead, the high-power laser facility would provide Britain's universities with a research centre for laser development, and the study of the interaction of laser light with matter. The joint proposal called for the construction of a  $1.5 \times 10^{12}$  watt (terawatt) laser. The SRC is now proposing a 0.7 terawatt facility at the Rutherford Laboratory, Harwell. At full strength, the facility would employ 40 scientists and engineers.

Before the SRC can go ahead with the project the Department of Education and Science (DES) has to give the go-ahead, which it hopes to do soon. One factor influencing the DES is the need for Treasury approval to purchase expensive equipment abroad. Although the Treasury turned down the AEA's request for money, there should be no problem with the SRC's request because new money is not involved.

While the Treasury has to approve the expenditure of money abroad, the SRC has not actually decided that it will need

to buy the necessary equipment from foreign suppliers. However, the only proven amplifiers capable of meeting the performance of the proposed facility are made in the United States by General Electric. In all, the laser—including the "driver" unit and the amplifiers—could cost £1.2 million. The SRC expects running costs to be £1 million annually.

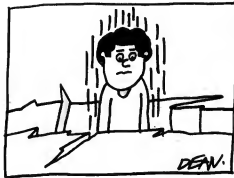
It is not clear why the AEA failed to coax funds out of the Treasury. The current economic situation clearly has had an effect, but there is also the security problem which has plagued laser fusion research. Britain already has a research effort in this area, at the Atomic Weapons Research Establishment, Aldermaston. When the AEA ran AWRE there was no problem, but the security at Harwell does not match that at Aldermaston. There are suggestions that SRC's plans could be upset by security problems, although the US has been setting the pace by gradually loosening the constraints on its laser fusion researchers.

Another factor could have been the change of feeling in the laser fusion community. A year or so ago there was talk of a laser fusion device operating by 1980; researchers now believe that laser fusion will be achieved only after a long and expensive research effort.

## Suppose you knew a quake was coming . . .

What do you do if, as seems likely, it becomes increasingly possible to predict the place and time of an earthquake? At a recent meeting of the International Geophysical Union at Grenoble three US sociologists turned up to offer their own predictions on such a warning's effects (*Le Monde*, 5 September). Dr J. Eugene Haas and Dr Janice Hutton (University of Colorado) and Dr Dennis Milet (State University of Colorado) started a two-year study last March based on two hypotheses: the prediction three years in advance of an earthquake of magnitude 7.3 on the Richter scale and another prediction of a 6.3 quake nine months in advance.

In both cases the warnings would seriously disturb economic life. The 7.3 warning might be expected to lower property values by 40 per cent (half that for a 6.3 quake) and produce much speculative buying. Some of the population



## Leeds breaks the silence

Leeds Council has made an astonishing admission of internal censorship on a scientific matter of public interest. For several years now it has been illegal to make any musical sounds louder than 96 dBA in the Leeds area and this limit has been widely criticised as over-protective and unrealistic. Nevertheless it is rigidly enforced and a check last week showed that there is still no pop music in Leeds.

As explained in *New Scientist* ("Does loud music make you deaf?" vol 65, p 254) the non-technical committee responsible for the legislation was probably misled by the figures supplied as reference material. The validity of much of the research data relied on has also been contested, but the Leeds Environmental Health Department has not only refused to talk to outsiders about the matter but has also refused to say why it won't talk.

Now all is clear. With a political swing to the right in the recent local elections the chairmanship of the Environmental Health and Control Committee has changed hands. As a result Leeds Council is free to talk to the outside world again and has admitted that "the enforced silence . . . over the past 12 months or so . . . has been at the direct instruction of the then chairman".

That one part-time councillor should have such power over the Leeds local authority on a matter of such wide public interest is alarming. Leeds Council should look into its affairs immediately and ensure that no comparable gags are still in force.

Adrian Hope

## US DDT ban has been beneficial

Since DDT was banned in the United States in 1972, there has been a marked decline in the level of DDT residues in human tissues, foodstuffs and the environment, according to a report sent to Congress by the Environmental Protection Agency. According to DDT—a review of scientific and economic aspects of the decision to ban its use as a pesticide, human dietary intake of the substance in the US declined from 13.8 mg/day in 1970 to 1.88 mg/day in 1973. Large-scale samplings also showed appreciable decreases in residue levels in human fatty tissues.

Most uses of DDT were banned by EPA in 1972. However, the Agency has administered the ban flexibly. It granted permission for DDT use in 1974, for example, to safeguard timber in the northwestern US from tussock moths.

According to the report, switching to alternative pesticides has cost cotton farmers—previously the biggest users of DDT—just over \$1.00 per acre per year on average, while the increased cost of cotton goods to the consumer has been just over two cents per annum. The economic impacts have been well within the range of those projected in 1972.

would move out, particularly during the last weeks before the deadline. A 7.3 alarm might drive out 10 per cent of the inhabitants during the second and third year, with a further 60 per cent leaving during the last weeks. The effects of a 6.3 warning would of course be less dramatic—20 per cent leaving in the last three weeks.

Despite the evacuation, there would be serious unemployment among those who stayed. First studies show that a number of firms would close temporarily or permanently. Business would fall off perhaps 25 per cent in the case of a 7.3 warning.

It would be incumbent upon the authorities, the sociologists said, to use the time of the warning period to reinforce dams, hospitals, schools, prisons, large houses, protect or move vital communications centres, computer complexes, laboratories, and essential archives, build stocks of food and other essentials in places outside the danger zone. The public would also have to be fully instructed what to do and plans for restoring the economy after the disaster would have to be put in hand.

# John Stuart Mill and the no-growth economy

The shape of the sustainable society may be moulded within the present generation. Among the immediate steps needed is the freeing of the contraceptive pill from all medical control

## Dr John Loraine

is chairman of the Doctors and Overpopulation Group, and vice-chairman of the Conservation Society

A steady state economy was first enunciated in 1857 by John Stuart Mill, in his *Principles of Political Economy*. Mill was deeply critical of the society which had followed in the wake of the industrial revolution which, to him, was characterised by "struggling to get on—trampling, crushing, elbowing and treading on each other's heels." The world of 1857 was much less heavily populated than is that of 1975, yet even then Mill's approach was staunchly anti-natalist. He considered that "the density of population necessary to enable mankind to obtain in the greatest degree all the advantages both of cooperation and of social intercourse has, in all the most populous countries, been attained."

Professional economists of the past 100 years have been exceedingly hostile to Mill's description of the sustainable society. His disenchantment with economic growth has been deeply resented; his contention that all economic policies must be judged in terms of their effect on birth rates has been derided. Indeed, the whole concept of the steady state economy has been depicted as a "personal aberration" quite out of keeping with Mill's other contributions to economic theory.

It is easy to see why Mill's views have met with such a consistently unfavourable reception. The outlook of most professional economists is pronatalist. To them, more people mean bigger markets; and birth control is perceived as a malign influence. To economists, as to contemporary politicians, businessmen and trade union leaders, economic growth is the panacea of many of our ills and a measure

of the "success" or "failure" of a nation in international affairs.

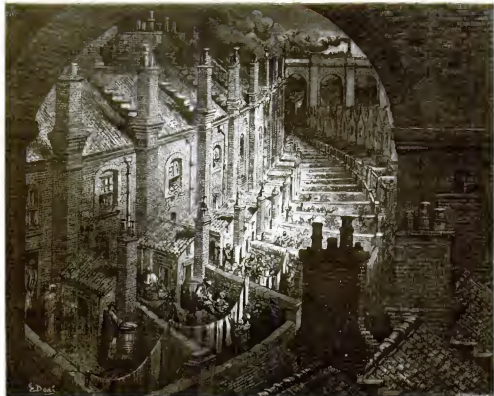
In Britain, the emphasis on economic growth and materialistic lifestyle became more dominant after the Second World War. Lord Butler once talked of doubling the standard of living in 20 years, and in 1959 the Conservative Party under Macmillan won a General Election under the slogan "You've never had it so good."

Today, slowly but surely, Mill's views are being vindicated, and the monolithic conventional wisdom of unbridled economic growth is starting to crack. In November 1974, for example, the Chancellor of the Exchequer, Denis Healey, proclaimed in his budget speech that "the senseless accumulation of material goods can no longer be regarded as the sole guarantee of human happiness or the measure of economic success."

Three main factors are propelling our planet towards a more sustainable type of society. The first is the explosive growth of population, especially in the Third World. The second is the inability of the environment to withstand indefinitely the strains imposed upon it by burgeoning industrialisation. The third is the recognition that many of the Earth's resources are finite, and that they can no longer be squandered with prodigal abandon.

The transition from a growth-orientated to a steady-state economy will be as fundamental as were the agricultural and industrial revolutions of the past. But whereas these earlier revolutions evolved sedately over

To John Stuart Mill, Britain was already overpopulated in 1857, at the height of the Industrial Revolution.



decades or centuries, the wheel of history is now turning much more rapidly. The shape of the sustainable society may be moulded within the compass of a single generation.

The precise characteristics of the sustainable society are emerging slowly and hesitantly. Rates of production and consumption will be low; the economy will be based on the conservation of stock and not on the maximisation of throughput. There will be a serious attempt to equate wants and needs. Individual products will be made more durable; recycling and reclamation will be actively encouraged; scarce resources will be carefully shepherded.

An essential feature of the sustainable society will be the maintenance of a constant population size. Birth rates and death rates will be equal and will be kept at the lowest possible level. Britain should in fact aim for an overall reduction of its population. At present, the UK is grossly overcrowded; indeed, discounting small islands and city states, the population density of England and Wales is exceeded only by those of Bangladesh, Taiwan, South Korea and the Netherlands. Overpopulation in Britain forces up land prices, exacerbates our housing problem, stokes the fires of inflation and contributes to overmanning in industry. A reduction in our numbers would, by contrast, make us more self-sufficient in food, less dependent on overseas markets for raw materials, and less ready to urbanise our vital agricultural sector.

Fortunately, there is now some indication that, in population terms, Britain is already moving in a direction favourable to the sustainable society. The crude birth rate in the UK has been falling over the past 10 years, and between 1971 and 1973 births decreased at a rate of 7 per cent each year. In 1972, the average family size was 2.4 children; by early 1975, the corresponding figure had fallen to 1.7. During the first four months of 1975 deaths exceeded births in England and Wales by 6600; this compares with a birth surplus of 5161 in the same period during 1974. Several factors are probably combining to reduce fertility in Britain. Inflation could well be acting as a form of birth control; lack of availability of housing for newly-weds may be operative; improved contraceptive services and a liberal abortion law may be playing a role.

#### Ingredients for control

The ingredients of a population policy in Britain have been much discussed in recent years. They include governmental recognition that the problem of over-population exists, widespread dissemination of contraceptive services, the provision of abortion on request, expansion of facilities for male and female sterilisation, and a determined effort through the media to educate the public in matters of population.

One measure could be put into practice immediately: to free the oral contraceptive pill from the medical umbrella and to sell it to the public without a doctor's or anyone else's prescription. A convincing case for this course of action has recently been made by

Professor Peter Huntingford, head of the departments of obstetrics and gynaecology of St Bartholomew's and the London Hospitals. Huntingford sees no reason why the situation in Britain should be any different from that of a number of Third World countries, where the pill has been on general sale for some time. He describes the current proposal that suitably trained nurses and midwives should dispense the pill as totally inadequate. Adverse effects of the pill can seldom be predicted from routine physical examination. As the Royal College of General Practitioners recently stated, "the estimated risk . . . of using the pill is one that a properly informed woman would be happy to take."

To attempt to forecast the population characteristics of the steady-state economy would be presumptuous. However, it is possible that the demographic situation might not be too dissimilar from the "very low fertility model" for Britain described in the *Report of the Population Panel* (HMSO, 1973). With this model, the gross reproduction rate would fall to 0.77 by the end of the 1970s, implying an average of about 1.6 births per woman. The model would produce an unprecedented change in the age population in succeeding generations. Thus, the panel calculated, the percentage of people under 15 years of age would fall from 24.1 in 1971 to 12.8 in 2051 AD; on the other hand, those in the 60-65 age group would rise from 16.1 per cent in 1971 to 26.8 per cent by 2051.

The implications for society of such an alteration in age structure are difficult to predict. However, worries about a declining labour force are probably exaggerated. The panel found that, with an average family size of 1.6 children, the ratio of workers to non-workers would be more favourable than at present.

Another fear which may have little substance is that in the steady-state economy an ageing population would tend towards conservatism and resistance to change. But modern history does not support this view. Throughout the 20th century, the median age of virtually all developed countries has been rising. Far from producing social stagnation and lack of adaptability to change, the past 75 years, despite their traumatic nature and numerous vicissitudes, have been one of the most varied and momentous periods in human experience.

To many people nurtured in the cosy philosophy of economic growth the whole concept of the sustainable society will appear bizarre and heretical. The major aims of the sustainable society will be to enhance the quality of life and to provide the fullest possible satisfaction for its members. John Stuart Mill summarised the position beautifully when he remarked: "A stationary condition of capital and population implies no stationary state of human improvement. There would be as much scope as ever for all kinds of mental culture, and moral and social progress; as much room for improving the Art of Living and much more likelihood of its being improved, when minds cease to be engrossed by the art of getting on."



# The structure of glucagon

Glucagon, a peptide hormone involved in control of glucose metabolism, has at last yielded a three-dimensional structure through X-ray analysis. Details of the structure have important implications for understanding the mechanism of action of the hormone

## Dr Tom Blundell

is a lecturer  
in the School of  
Biological Sciences,  
University of Sussex

The extraordinary potency of hormones, which has fascinated scientists for so long, is related to the part they play in control mechanisms which integrate and regulate complex metabolic processes in living organisms. Hormones are chemical substances manufactured and secreted in minute quantities by specialised tissues. They travel through the blood stream to remote target tissues and produce characteristic physiological effects. They may participate in a "feed-back" control mechanism. For instance the release of glucagon from the pancreas is stimulated by, amongst other things, low circulating glucose levels. The effect of glucagon is to release glucose from liver cells to boost blood glucose concentrations. Its action is antagonistic to that of another pancreatic hormone, insulin, which is responsible for lowering unduly high circulating glucose levels. A fuller understanding of the complex mechanisms controlled by glucagon and insulin is one of the main objectives of people studying the causes and cure of diabetes.

There are many problems concerning these hormones which we have yet to solve. Earl Sutherland and his colleagues at Western Reserve University showed that the action of glucagon on the receptor led to an increase in intracellular levels of a "second messenger"—cyclic AMP. We know that this second messenger activates a series of enzymes involved in the breakdown of glycogen to glucose. However, we know very little about the detailed nature of the glucagon-receptor interaction. Martin Rodbell and his team at the National Institutes of Health, Bethesda, have shown that glucagon binds to a receptor protein, regulating the catalytic activity of adenylate cyclase, the enzyme which is responsible for the conversion of ATP into cAMP. Results from other workers show that many different hormones with varying sizes and degrees of complexity of their covalent structures have a similar effect, but each appears to have a specific receptor which mediates the intracellular response. How is this specificity achieved?

One essential prerequisite to understanding the hormone-receptor interaction is a knowledge of the three dimensional structure of the hormone when bound to the receptor. Glucagon and insulin are polypeptide hormones, that is they are chains of amino acid residues linked together in a specific primary sequence. The sequence of porcine glucagon is illustrated in Figure 1a. This was determined in 1957 by William Bromer and his colleagues at the Lilly Research Laboratories, Indianapolis.

The sequences of a number of other polypeptide hormones such as insulin, the growth hormones, and adrenocorticotrophic hormone (ACTH) are also known, but the three

dimensional structure of only one of them, insulin, has been established. This was the achievement of Dorothy Hodgkin and her team at Oxford, who carried out the X-ray analysis of insulin crystals. Dorothy Hodgkin started this project in 1935, and finally achieved success in 1969; the detail has been improved since then.

My own part in that project spanned six years, and was rather a modest contribution to the total effort. Since leaving Oxford and establishing a similar group concerned with X-ray analysis of protein crystals at Sussex University, my colleagues and I have obtained our first results on glucagon. We can now describe the structure of this hormone. The results are exciting not only because this is the second polypeptide hormone structure to be described in this way, but also because the glucagon structure is quite unlike any protein structure which has previously been studied by the X-ray method.

## The first X-ray pictures

Glucagon was first crystallised in 1955 by A. Staub, L. Sinn and O. K. Behrens in a cubic form, and soon after Murray King produced X-ray photographs. King worked on the project for a number of years, and eventually in 1965 published a "low-resolution" model of the structure which was essentially correct, but he was unable to provide a detailed molecular model. William Lipscomb and William Haugen of Harvard University then attempted to use the technique of isomorphous replacement to solve the structure. This method, which was pioneered for protein structure analysis by Max Perutz at Cambridge, involves the addition of an electron-dense atom to the crystal structure without disturbing the crystal packing. Lipscomb and Haugen were able to prepare some derivatives with electron dense atoms, but the analysis failed to proceed smoothly, and at the beginning of 1973 Lipscomb suggested that we should attempt the X-ray analysis. Later in the summer he generously provided us with a summary of his own experiments over the previous years.

One of main worries about the structure analysis of glucagon was the fact that the crystals were obtained from slightly alkaline solution whereas glucagon acts physiologically under more neutral conditions. As soon as we had mastered the trick of growing large crystals under alkaline conditions, as shown in Figure 2, we experimented with changing the mother liquor surrounding the crystals to a more neutral pH. These experiments were carried out by Ian Tickle, John Jenkins and myself in the spare moments we had during the installation of our X-ray generators and computer-controlled equipment in the biochemistry laboratory at the

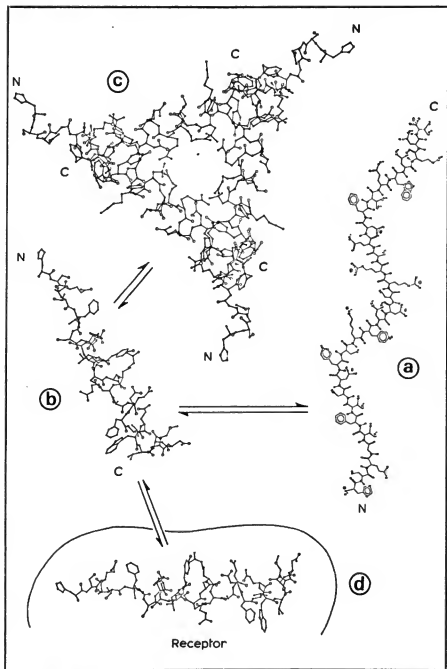


Figure 1 Glucagon (a) is a polypeptide hormone containing 29 amino acid residues which has different structural forms in solution. One structure is helical (b) and this can form trimers (c) at high concentration. A similar helical structure binds to the glucagon receptor (d)

University of Sussex.

We found to our dismay that our crystals became very cracked, but surprisingly still diffracted X-rays rather well. The X-ray diffraction patterns indicated large changes in the crystal structure. These results emphasised earlier observations that glucagon in solution is a very flexible molecule, and it became apparent that it might also be rather flexible in the crystals. When we repeated the experiments throughout the summer, we identified a wide range of different but related crystal structures which we eventually concluded must result mainly from temperature variations. As the autumn drew on and we made proper controls on the temperature, our results proved to be more reproducible.

Having identified changes in the structure Ian and I spent some time trying to characterise a set of conditions under which the crystals were relatively stable. Under the more alkaline conditions we found that structural transitions could be induced by adding the very electron-dense atoms which were necessary in the method of isomorphous replacement. However, at slightly acid conditions we were able to add platinum and silver ions without disturbing the structure. Much of this work was carried out by Dorota Adamiak, a Polish post-graduate student who visited our laboratory for a few months. Soon we had measured the few thousand X-ray intensities from the native glucagon and derivatives, and we were able to calculate some mathematical functions, from which we deduced the positions of the electron-dense atoms.

### The molecular structure

At this point in the summer of 1974, Dr Kyoju Sasaki from Nagoya University in Japan arrived to spend a year with us, and later Susan Dockerill also started her post-graduate studies. They both worked enthusiastically on the glucagon X-ray analysis and recently we computed an electron density map (at 3 angstrom resolution) which revealed the molecular structure of the hormone.

The individual glucagon molecules have a distorted  $\alpha$ -helical structure but the chain is more extended at the amino-terminus (Figure 1b). The molecules are arranged in cubic symmetry and there is a complex arrangement of glucagon in trimers, which are illustrated in Figure 1c. The arrangement is such that the oily, or hydrophobic, parts of the structure are packed against each other and the polar side groups are freely interacting with the solvent which comprises about 40 per cent of the volume of the crystals. The structure is unique in its lack of a globular nature; the polypeptide is not folded upon itself to give a hydrophobic core in the way found in all proteins studied previously by X-ray analysis. In fact, this unusual structure together with the knowledge that glucagon is flexible in solution poses a very obvious question: Has this structure any relation to the structures found in solution?

Circular dichroism—a spectroscopic technique which allows us to probe the structure in solution—indicates that the molecule probably has a similar structure in solution, but only when aggregated. Furthermore, glucagon aggregates in solution as trimers in a similar way to that found in our crystals. It appears that glucagon is a flexible structure—it exists as an equilibrium population of conformers—one of which is stabilised by association with the hydrophobic surfaces of other glucagon molecules, as shown in Figure 1.

These results are similar in some ways to those found for the structure of insulin molecules which associate as dimers, and then in the presence of zinc as hexamers. The driving force of this association is the burying of the

hydrophobic groups in the interior of the protein aggregate. However, the insulin molecules have a well-defined globular shape like other proteins which is not significantly altered by association.

We must now ask what relevance our results have for the physiological role of glucagon, and how the results compare with those for insulin. Glucagon is stored in the A cells of islets of Langerhans in the pancreas as granules, which in most species appear to be amorphous. However, Reiner Lange of Giessen has observed crystalline granules in some fishes and these seem to be very similar to the crystals we produce in the laboratory. It is an attractive idea that glucagon, when stored in the A cells, forms granules which contain glucagon trimers. This would have the great advantage of providing a storage form for the glucagon which would be thermodynamically more stable and less susceptible to enzymatic digestion. In fact, insulin is also stabilised in a similar way: it is stored as zinc insulin hexamers arranged in crystalline arrays.

When the glucagon is released into the blood stream it exists in such low concentrations that the trimers must dissociate and the hormone circulates as a monomer adopting a random conformations. Rodbell has shown that the binding to the receptor is largely determined by hydrophobic interactions and Harold Edelhock has demonstrated that in the presence of a hydrophobic surface the molecule assumes a helical struc-

ture. It seems likely that the structure is the same or very similar to the structure found in the trimers as this is also induced by hydrophobic interactions. Studies on modified glucagons are also consistent with the idea that the whole of the helix region must be present to promote receptor binding. We have, therefore, tentatively drawn the helical structure binding to the receptor in Figure 1d. However, it appears that the amino terminus of the glucagon chain, which is not part of the helix, may be more important for invoking the catalytic activity of the adenylate cyclase than in binding.

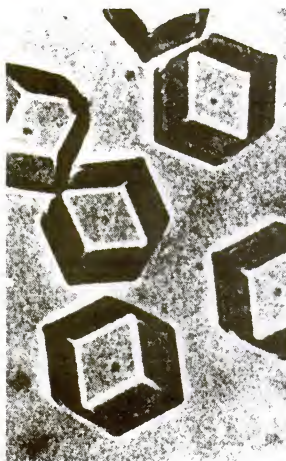
### Interactions with receptor

Insulin hexamers also dissociate when they are released into the bloodstream and insulin is almost certainly biologically active as a monomer. Rod Pullen and Steve Wood in our laboratory, in conjunction with Norman Lazarus, at the Wellcome Research Laboratories, Helmut Zahn, Axel Wollmer and Dietrich Brandenberg of Aachen, Germany and Jorgen Gliemann and Steen Gammeltoft in Copenhagen, have shown that modified insulins or insulins from certain animals, like the guinea pig, which have decreased biological activity, have an altered three-dimensional structure. The results of researchers from many laboratories indicate that the insulin receptor binding involves a specific three-dimensional arrangement of the insulin amino acid residues, many of which are hydrophobic. This specific arrangement would be difficult to achieve unless the structure were more rigid than that of glucagon.

Thus there appear to be parallels in the physiological role of glucagon and insulin. Association of molecules may bury the "hydrophobic" receptor binding region during storage in granules, and both hormones appear to use this "sticky" region in binding to the receptor. However, it seems that the glucagon molecule, unlike insulin, is sufficiently simple to have a flexible structure, and a single conformer is specifically induced on receptor binding. Both hormones must be degraded very quickly once they are circulating otherwise the hormone action would linger on and the sophistication in the feedback system would be lost. It seems that insulin may achieve this by having a disulphide bridge on the surface which is easily cleaved with a loss of biological activity. Glucagon probably achieves the same end by having a flexible structure which is easily cleaved by degrading enzymes.

Thus, in both these hormones, Nature has designed a system which gives specificity through binding of the hormone in a well defined three-dimensional arrangement to the receptor, stability in storage but fast degradation once the hormone is released. It will be interesting to see whether other polypeptide hormones are designed in a similar way to either glucagon or insulin, or whether there are still other ways of providing a sophisticated "feedback" system for regulation of biological processes by polypeptide hormones.

Figure 2 Cubic crystals of glucagon.



# Forum

## Westminster scene

### Universities and devolution

Accurate but naturally truncated reports in the national press of part of my address to Section X of the British Association at Guildford, on the relationship between a putative Assembly and higher education in Scotland, seem to have generated some heat. I hasten to add that all was tranquil in the teaching block of the University of Surrey when delivery took place, and the only comment on this part of my speech was one of assenting concern—not that one would expect fusticuffs with Sir Alan Cottrell in the chair, and an audience which included Sir John Baker and Sir Bernard Lovell.

What I asked at Guildford was that no one should be left unaware of what is at stake, in the issue of, as one involved civil servant called it in an unguarded moment, this "devolution caper". The correct Civil Service term is Devolution Exercise. It is neither more nor less than the break-up of the United Kingdom as we have known it, since 1707.

In particular, I addressed myself to the proposal that the Scottish universities and research in Scotland should be made responsible to the Edinburgh Assembly. Make no mistake about it, this proposition is being seriously canvassed inside the government. Not that many Ministers believe for one moment that the Scottish universities would do better outside the framework of the University Grants Committee.

The brutal reality is that Ministers, having the millstone of an electoral promise of an Assembly around their necks are conscious of the charges that will be made that the Assembly, if set up, will have all-too-little to do. To justify 150 Assemblies, they are frantically wallowing around to find something for it to do. And what could be more prestigious than control over the universities and higher education? I can think of an array of possible Members of the Edinburgh Assembly who would adore nothing more than meddling with the running of the universities on their doorstep. Judge for yourself as to whether such a situation would improve the work of higher education.

Furthermore, even if, by some miracle, the universities are excluded from the claws of the Assembly for the present, you can bet that once an Assembly is established, even ill in Scottish higher education, real or imagined, will be attributed to the fact that the Assembly's powers do not cover that field. It would only be a matter of a few years, once an Assembly was established, before the universities of Scotland were swept under its control.

All right, say my critics, why should this be so horrific a prospect? The short-hand answer is, first from the point of

view of student composition, and secondly from the point of view of professors and lecturers.

At the point that universities passed under the control of the Assembly, the forces, already evident, clamouring for giving priority to Scottish residents as students at Scottish universities would become irresistible. The Scottish universities, obtaining finance via the Assembly would be in no position to deny places to young men and women residents in Scotland even though some applicants from South of the Border were better qualified. Then, the laws of tit-for-tat would inevitably begin to operate. English universities would retaliate in kind, and in a twinkling this would be the break-up not only of UCCA, but of a healthy system whereby students from one part of the UK often go to another for higher education.



The leavening of English students is positively good for the Scottish universities, and I would like to think that the many Scots at English universities as undergraduates or postgraduates make a welcome contribution. (If anyone thinks I'm scaremongering, just let him ask himself how much interchange there is with the different system in Eire, compared to the role that Trinity College, Dublin, played before 1914.)

Perhaps more serious is the prospect of a split in the university system between Scotland and England in relation to staff. Theoretically, it is easy enough to say, as my critics do, that there would be nothing to hinder a lecturer in one system applying for a job in the other. In practice, we all know that such applicants are disadvantaged—indeed, this may become more pronounced if we move into a position where university jobs become scarcer. Comparatively little flow takes place between Scotland and England for promoted posts in school education, where the systems are different.

Already we know of lecturers, occupying posts in Scotland, who have applied for and obtained jobs in English universities, partly because they detect the writing on the wall, and don't want to become enmeshed in a smaller higher education system, in which there will be less career choice. To anyone who thinks I'm producing a bogey, I would ask them to recall the fuss and consternation in certain quarters when Tom Cottrell's successor as Principal of Stirling University was appointed, albeit he was a distinguished Scot, whose last post had been in England. Equally, it would be a

terrible loss all round if the English universities felt obliged to cast a cold eye on applicants for jobs who were born in Scotland, let alone wonder about the contracts of Scots on their staff.

No less important is the threat to break up responsibility for the UK research pattern. At Guildford, it was interesting that the IPCS representative in the audience should comment on the terribly unsatisfactory position at present whereby agricultural research in Scotland is the responsibility of the Scottish Office. Distinguished though places like the Rowett in Aberdeen and the ARC units in Edinburgh are, he claimed that even given good personal relationships with their colleagues in England, it made no kind of scientific sense from the point of view of Britain to have separate responsibilities.

Before any break-up of the UK research pattern, the government really ought at least to be able to state that the scheme has the full-hearted approval of Professor Sir Frederick Stewart, chairman of the Advisory Board for the Research Councils, and himself the holder of an Edinburgh Chair, and of Professor Sir Samuel Edwards, chairman of the Science Research Council. Moreover, one should ponder whether any change either in responsibility for research or the universities should be made in the face of overwhelming votes by the Association of University Teachers both at Edinburgh and at Glasgow, against the break-up of the UGC.

It is perhaps an ironical comment on the situation that one heavyweight Professor who has been converted to the idea of responsibility to a Scottish Assembly is Professor McIntyre, ex-acting vice chancellor of Edinburgh, who seemed stricken on the road to Damascus at a recent conference on devolution organised by the *Times Educational Supplement*. McIntyre is a Professor of Scottish Theology, not a topic taught in universities throughout the UK in great numbers. Could the advocates of responsibility to a Scottish Assembly not dig up a single heavyweight science professor to espouse their cause? I suspect they couldn't. Tam Dalgell MP

## New York view

### Weather or not

Plus ça change, plus c'est la même chose. Science seems to move in cycles, and at no time is this more evident than at the end of summer, when academics are returning to college from their holiday retreats and university public relations men are scrambling more than normal to dig out scientific stories of interest. Thus, it is hardly surprising that the science headlines of late have had a well-worn look about them. In New York, an earth scientist is projecting future climatic conditions in the light of this summer's remarkably high temperatures. In Buffalo, a group of scientists issues a statement castigating the general public's ready acceptance of a pseudo-scientific cult (see Feedback, last week). And,

in Chicago, a psychologist presenting a paper on racial differences in intelligence quotients is greeted by protesters shouting "racist" and other epithets.

The most intriguing of these incidents from the strictly scientific point of view has been the contention of Columbia University geologist Wallace Broecker that the Earth is about to start warming up, rather than continuing to cool down as the current meteorological wisdom has it. The belief that the climate is set into a long cooling trend has come largely from measurements of mean temperatures in the northern hemisphere. These have led experts to conclude that the Earth passed through an unprecedented warm period in the first half of this century, and is now drifting back to the much cooler conditions that obtained between Elizabethan and Victorian times, when the Thames regularly froze in winter.

This apparent return to a "mini-ice-age" is by no means a steady one. Meteorologists who believe that it's happening assert that its major characteristic is a series of extreme local weather conditions, such as extended droughts, misplaced monsoons, and even long hot spells of the type suffered in much of Western Europe this past summer.

This scenario of a gradually cooling climate has been a matter for some controversy, mostly concerning the eventual extent of the cooling. But Broecker goes to the extreme of reversing the trend, arguing that the climate will start to heat up noticeably within the next 10 to 20 years. He bases his theory on two considerations: First a series of oxygen-18 measurements on snows from Camp Century in Northwest Greenland, which give a 700-year record of climatic conditions. And secondly, calculations of the heating effect of the carbon dioxide that is being vented into the atmosphere in increasing amounts as a result of Man's activities. The Camp Century data, asserts Broecker in *Science* (vol 189, p 460) indicate that the Earth experiences an 80-year cycle of warming and cooling. He adds that according to present indications the cooling trend is about to end and give way to renewed warming.

This warming effect, Broecker says, will be exacerbated by the "greenhouse effect" of carbon dioxide released into the atmosphere by the burning of chemical fuels. The geologist estimates that the annual amount of carbon dioxide reaching the atmosphere in this way will increase to about 913 thousand million tons by 2010, by contrast with just 21 thousand million tons in 1900 and 242 thousand million tons in 1970.

So far, Broecker believes the cooling part of the 80-year cooling-warming cycle has obscured this greenhouse effect: but once the natural cycle brings in fresh climatic variation, it will become extremely important.

"Global temperatures would begin a dramatic rise which, by the year 2000, would bring average temperatures beyond the range experienced during the last 1000 years," he concludes. "Until chemical fuel consumption is dramatically reduced, global temperatures would



ROBERT

continue to rise. Future natural cycles would merely modulate this ever-steepening rise".

Broecker's theory has some support from independent measurements of average temperatures in the southern hemisphere by New Zealand researchers, but it is undoubtedly controversial. For a start, many meteorologists feel that the Camp Century snows are somewhat unreliable indicators of climatic changes. In addition, experts believe that he is overemphasising the likely warming effects of carbon dioxide.

★ ★ ★

One scientist who frequently receives publicity that he does not seek is Arthur Jensen, the Berkeley psychologist who sparked a scientific firestorm six years ago with a paper on hereditary racial differences and intelligence quotients. After a few years of notoriety, Jensen faded back into the academic shadows. But early this month, at the 83rd annual convention of the American Psychological Association in Chicago, he emerged with a new theoretical wrinkle. The observed differences in IQ scores between whites and blacks, Jensen hypothesised, are caused by what he terms a "G factor", which measures the individual's ability to perform complex mental tasks. This inherited factor, said Jensen, is measured in all standard IQ tests, and is the key to explaining why blacks traditionally do worse on such tests than whites.

Not surprisingly, Jensen's talk was greeted by an array of demonstrators, carrying signs that read "Say no to Jensen", "New Nazi threat", and the like. But as an indication that this is the settled seventies rather than the turbulent sixties, the protesters let Jensen give his paper with hardly more than a smattering of verbal threats. Given the complexity of Jensen's treatment, it could be that they were driven to sleep by the talk.

Peter Gwynne

## EEC notebook

### Unity search

While progress can hardly be described as dynamic, at least the institutions and national governments of the European Economic Community are beginning to face up to the hard facts about the skeletal concept of European Union. Belgian Prime Minister Leo Tindemans, nominated Mr European Union by the heads of governments of the Nine, reports back to the summit in December with the results of his year-long probe into the prospects.

The Commission has already handed in its paper, and most of the nine govern-

ments have prepared their views. The public appears to have made up its mind, regardless of the lack of information. In the latest public sampling, according to the Commission, some 70 per cent of the population is in favour of European unification. But the fact remains that no one appears to have any very clear idea of what union or unification is.

At least all seem agreed that the original target of union by 1980 is now hopelessly overoptimistic. The Commission admits: "Public opinion, while still generally in favour of Europe as a unity, has gradually ceased to regard the community as a political venture in its own right, and has become increasingly sceptical." First job, says the report, must be to "restore credibility and relevance to the common venture . . . and to reactivate existing common policies."

A special investigative committee report to the Dutch government takes a similar line; discarding as unrealistic any suggestions that it should draft "attractive but as yet unattainable models." Nevertheless, underlying the preponderant vagueness is a striking candour which offers some promise of a much more hardheaded approach in the future.

Hopefully, thankfully, we shall be spared further repetitions of the hyper-ambitious 1972 Paris summit declaration, when the presidents and prime ministers "set themselves the major objective of transforming before the end of the decade . . . the whole complex of the relations of the member states into a European union."

The Dutch committee pulled no punches. On Euratom: "Little or nothing has been achieved of the objectives." Transport and energy: "One can scarcely speak of common policies." Free movement of capital: "Things have in fact gone backwards." Social policy: "So far little substance in spite of handsome declarations of intent." Coordination of economic policy: "Still completely ineffective." The Dutch also accuse national governments of taking refuge in national protectionism, and more seriously of allowing the Community institutions, particularly the Commission, to become enfeebled almost to the extent of complete impotence.

The indictment closes: "There are disturbing indications of a breakdown . . . and a serious danger of a progressive decline ending in a wasting away of the Community's achievements."

Plainly, the job at hand is a major underpinning of the Common Market's foundations. And, as the Dutch imply, the nine countries could do worse than undertake an intensive refresher course on the treaties which are supposed to bind them together.

None of our leaders can deny that they have made a hash of things. Of course they have plenty of excuses. The 15-year-old world monetary crisis and the 1973 oil war have combined to drain the political energy out of the authorities. But the Commission study group on "union" which reported in the spring was obviously right to condemn the "lack of political will by governments". Instead of provoking concerted action, it said, the crises of recent years have produced



"a general loss of nerve, each government doing its best to find its own way out of trouble. National economic and monetary policies have never in 25 years been more discordant, more divergent than they are today."

All terribly depressing. All terribly familiar. And all terribly true. Prime Minister Tindemans has spent a year picking over the bones. But no one expects him to come up with any new or exciting ideas to launch Europe back on the road to union. The most we can hope for is that his report prompts the leaders to put aside their fantasies about economic, monetary, foreign policy and defence union and get on with piecing together the fragments of the Community as it stands.

All candidates for the refresher course should now turn to Article 3 of the Treaty of Rome . . . *Christopher Parkes*

## Perspective

# Breaking through the disenchantment

The age of enlightenment has given way to the age of disenchantment. As recently as the 1960s, to call an argument "scientific" was a compliment; it is fast becoming a slur. And yet science is knowledge.

Those like Roszak and Marcuse who with great eloquence attack the institution of science and its vast ramifications through modern society attack not only its institution (which, any radical would agree, is decrepit) but point straight to what they see at the heart of science: an inhuman drive to manipulate and control.

I want to argue here that, however right Roszak and Marcuse may be in their observations of the heart, they have missed the brain—the motivator—of science: an unshakeable belief that there is an objective reality, around which imagination hovers. Matter is at the centre of the world, not mind. The failing heart, in the face of massive human and political problems, is to my mind the failure of an anachronistic scientific method which relied on treating essentially simple problems from which inessential could be pared away. It's from this method, not the view of reality, of science that Marcuse's concept of manipulation arises.

The crude scientific method is expendable. Historically science has flourished by making a choice of problems in which irrelevances can—with some difficulty—be identified and cast aside, leaving a reduced problem which requires a simple and elegant solution. The problem of force and motion as solved by Newton is an example. Friction had to be eliminated. Essentially complex problems—like most do with life and living—from which nothing can be removed, in which no lines can be drawn, are beyond the competence of the historical scientific method.

Yet scientists should not despair. We should be aware now of the limits of crude objectivity. We should be aware

now of the human context within which scientists choose their problems and find their solutions. (This last—the social context of science—is a concept which would have been impossible in the enlightenment, when science was taken to include the whole of human affairs. It has grown up only through the honing down of a limited scientific method powerful in its technical sphere but isolated from the rest of life.) We should be as aware of the limitations of institutionalised science as a previous age was aware of the limitations of dogma and institutionalised religion. Between dogma and crude science there should now light up the narrow way of truth.

That there is an objective reality and that intuition and imagination can afford only approximations to that reality—that is the life and breath of science and must be guarded to the death against the forces of barbarism. Yet what the scientist must now admit is that in many problems of great consequence to people reality may not be accessible, in practice, through entirely manipulative and analytical methods. These methods have already, in my opinion, bruised sociology and economics and even medicine in the attempts of these disciplines to imitate what was thought to be "science".

There is an extraordinarily difficult balance to maintain between a thorough belief in objective reality and a sensitivity to the complexities of human problems. But it's one that, if it can be maintained, can at last do justice to the thoroughgoing scientific optimism of the enlightenment.

The scientist moving into more humane problems and hoping to contribute to a 20th century re-enlightenment has I feel, to cope with two new freedoms. The first is that the very choice of problems can affect the solution. (Face a football hooligan. What is the problem?) The second is that there will always be more than one solution. To both the scientist must inevitably apply values. The scientific idea in the face of a complex problem cannot be value free. This applies as much to problems of technology (which cannot be isolated from their social context) as to problems of, say, economics.

Science as the repository of all objective knowledge and the crucial concept of objective reality, must not remain rigidly attached to its historical "method" if it is to survive the persuasive attacks of the antiscientists. The delicate plant, objective truth, will survive only if the institution of science is prepared to adjust its methods to deal with complex problems, and admit the existence of human values.

*Robert Walgate*

## Pig-ignorant

# About nature

I had the pleasure, while rustivating the summer away, of reading Gerry Leach's excellent study of farm energetics (*Energy and Food Production*, IIED; see *Energy File*, 21 August) with the attention it deserved. It was most agreeable to follow his calm and reasonable argument—one has become accustomed to an almost ob-

ligatory hysteria in papers on this subject—and an amusing put-down for my farming friends to be able to tell them that for all their efforts they produced about as much food energy as the Kung bushmen of the Kalahari desert.

As I understood the paper, the amount of energy used in farming is not all that excessive. It sounds terrible to say that it takes 5 joules of fossil fuel energy to produce 1 of food, but when you compare the nutritious qualities of a plate of mutton and one of crude oil, the whole thing falls into a better perspective.

A point about modern farming which the city dweller understandably overlooks is the importance of speed. For instance, if you are going to keep sheep, you must grow turnips to feed them over the winter when grass doesn't grow. You sow them in early summer, and there comes a point, two weeks after the plants show above the ground, when you must hoe the weeds out. You have just a week to do it in: if it rains for 6 days, so that you have to do your 20 acres on the seventh, you thank your stars you replaced the slow 20hp Fergie with a 60hp fuel gobbling ecological monstrosity which can get over the ground in the time available.

The same thing applies to many other operations. Grass for silage must be cut in a window about 5 days long for maximum feed value. Once again the man with an 80hp tractor has a much better chance of completing the job than the one without. And the man with a horse—which eats 12 per cent of the farm's produce anyway—can't even begin. It is a curious modern form of puritanism to feel that a powerful tractor is somehow wicked, and that a horse is morally better. Yet many people do feel it, and I must admit to a twinge or two myself.



Of course there are rationalisations. The tractor uses irreplaceable energy, it is true; but whenever we make a road, we use irreplaceable limestone. Yet one does not feel guilty about the limestone. True, there seems to be somewhat less fuel about than limestone, so the energy moralists rationalise further and say their concern is for posterity.

What they mean is that posterity can't go on being as lavish as we are today. But that should please them, for today's lavishness is just what they object to.

Not only is this moral stand rather illogical, it is also rather dangerous. "Posterity, what crimes are committed in thy name?" I have learned to be deeply suspicious of anyone who claims to be acting for the unborn. It is almost always a cloak for fascism. Hitler was very keen on posterity: his obliteration of the Jews and the devastation he caused in Russia were ostensibly to prepare a fit homeland for future generations of Germans.

No doubt he would have had little time for Groucho Marx, but as that great thinker once enquired: "What has posterity ever done for me?" And this is a question which energy reformers might bear in mind.

It seems to me that many critics of energy policy are in fact making theological points, but are hamstrung by their rational, science-based training. What they want to do emotionally is to destroy an industrial and economic system which a) is boring, wasteful, soul-less (and I agree with all that), and b) has no time for them.

To do this they are constrained by their training to make "scientific" points. Then ensues a brisk debate which gets nowhere because the defenders of the existing order simply go on doing what they are forced to change by circumstance. And the critics say they ought to change because all sorts of frightfulnesses will happen—even though we can all see that they are not. It is very sad to see the feelings straining through the dry tables and impersonal projections, simply because the authors have no other means of expression at their disposal. Still, Leach's paper is happily free from such emotional freight, and makes a very interesting read. *Peter Laurie*

## Venture

### Choice growth

"Self knowledge; the exploration of the material world and the people who live in it; the training of the intellect; the development of the creative and aesthetic senses; the challenge of moral principle and the response to it; the awareness and understanding of spiritual values," is how a recent DES survey describes one topic in the school curriculum. Such all-purpose worthiness might sound like religious knowledge, English, social science or even psychology. But all of these are seen as nonsensical or boring by many teenagers. Every student is thinking about a job though, and the subject is careers education.

Adrian Bridgewater first became interested in career guidance as an undergraduate at Cambridge. He started a beautiful photojournal called *Image*, which depended largely on advertisements from industry. Soon *Image* was carrying down-to-earth articles about working for Pye, or Benton and Bowles. Bridgewater managed the magazine for a year, after coming down in 1960. "Friends used to come down to London for a briefing at eight and then went out to call boxes, with their threepenny bits, selling on commission."

Bridgewater held a job for three years, mainly selling space in a Register for Graduate Employment, for Cornmarket Press. He didn't like it much. "As you know, one needs the frustrations, and a friend to get something going." With Tony Watts he left and started the Careers Research Advisory Centre (CRAC).

"It was very naive. We had no capital, so we started a non-profit company. We wanted to provide an information ser-

vice with career teachers paying in advance."

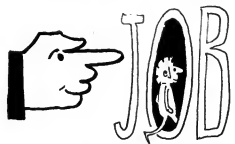
For a year they drew no income, while living on mortgage money or vanishing private means. At first they sold details about how to become a ship's purser, a speech-therapist, a time- and motion engineer. Then, the Robbins report led to a massive expansion of university education in the mid-1960s.

"There was a tremendous demand for information about how to get into the different universities, and for 'course comparisons'. We used to sell cyclostyled sheets at sixpence. Now we sell booklets for 85p. It sounds terrible doesn't it? We sold £46 000 worth last year. We are pretty sure that every school that sends people to university uses them."

Gradually the business grew. CRAC launched a series of booklets for school-leavers: *Your choice at 14+, ... 16+ ... 18+*. These were sold almost entirely by direct mail. There were courses for career teachers. "They all wanted help on how to get their mediocre pupils into university. Their bright ones were OK, they thought."

Gradually it became clear that many of the most important decisions were being made, by default, long before people left school. "They've got to understand the implications of dropping science. Liam Hudson showed that many of the best scientists were going into pure science instead of engineering which would help themselves, be more fun, and help the economy."

Steadily CRAC published more and more imaginative booklets. To cut prices there were huge print runs, costing as



much as £8000. Five years ago all the credit lines were stretched taut, with the business owing up to five months as its only means of financing its growth. Bridgewater called in consultants and followed their advice. A new business, Hobsons Press Ltd., bought all the CRAC copyrights for £100 000, and guaranteed a royalty income. Most of the staff moved to Hobsons and the commercial pressures were lifted from CRAC. Now with £30 000 of investment and £100 000 of borrowings Hobsons-CRAC has a turnover of £650 000 and a conservatively accounted profit of around £8000 last year.

There is a simulation of careers policy-making for teachers. They fill in the basic philosophy, eg "all parents welcome at any time", and then work out how to implement each aspect on the teaching timetable. There are courses on decision making, on feeling, on working in groups, on evaluating for school kids. There are job simulations to show you what it feels like to be a receptionist,

a proof-reader, a transport-clerk, a policeman or woman, a bank teller. These are often financed by an individual company which gets its name on the package. How much?

"The company pays about £600. It's very good publicity. There are business games ... running a garage, or trying to clear up a polluted river. We have courses for graduates about industry. And there is material for people who don't enjoy reading, too."

How about a simulation of doing-your-own-thing? Or does everyone assume that providing jobs is someone else's problem? "It would be very good. But the difficulty is the teachers. They reject any sort of material that smacks of capitalism. I'm a liberal, verging to the right. But most teachers are very loath to impose any outside value-system on pupils."

CRAC has just set up in Australia, with three people. There are many other Commonwealth countries that may also be suitable. It is a joint sponsor with Hatfield Polytechnic of the National Institute for Careers Education and Counselling. But the DES survey showed that more than half our schools have no policy at all and only about one in eight really knows where it is going with the tinker, tailor, soldier, sailor business.

*Tim Elliott*

## A groundling's notebook

### In conference

This is the season of the year for portentously framed statements of the banal, the obvious and the outrageous. Platitudes resound as the members of a myriad learned societies, associations and professions (or would-be professions) help our increasingly impecunious universities and other residential centres of higher learning, by briefly occupying their halls of residence (expensively empty during the long vacation) for the statutory annual meeting, conference, or (if the sodality concerned be very grand) congress.

You have to have a late summer or autumnal gathering involving at least two nights away from home, but, ideally, an entire week, if your organisation is to make any kind of serious bid for recognition as a force in contemporary affairs. The annual wappenshaws of the TUC, the Socialists, the Conservatives, the Liberals, the British Ass, and the BMA are but the most loquacious and brashly publicised of a vast and constantly shifting country-wide mosaic of such chateaus.

In addition to slightly relieving the gloom of our collegiate bursars, this particular form of midsummer madness also helps British Rail (your average conferee appears to be able to travel by train without ripping up the upholstery and smashing the lights and windows). Conferences also tide the printing trade over the dog days, and provide a much-needed seasonal boost to the sale of duplicating paper. They certainly comfort many thousands of our worthier and more serious-minded citizens who can face the rigours of the

coming winter all the better for having had their morale boosted by the knowledge that they have once again demonstrated their active support for the cause of their choice.

It is, you might think, an entirely innocent pastime, enjoyed by the participants, benefiting many beside, and harming none. And so it would be, but for all those speeches and papers and communications and resolutions. The trouble with a conference is that at some arbitrary date, a greater or lesser number of people selected from among the members of a commonly closed and restricted group are required to produce new ideas and new findings based upon fresh thinking or recent and novel experience or on original research, and to transmit the fruit of their labours to the enrichment of their audience.

That, at least, is the theory. It is what conferences are all about (or so their organisers would have us believe). But it is an aim impossible of fulfilment. There just isn't that much original thought around. If scientists or Socialists or spiritualists, or Methodists or miners or magistrates could so advance their understanding of their skills and purposes and roles in the affairs of men that an annual talking marathon was really necessary in order to report and consider the year's achievements, the progress of society toward stability and sanity would be so great that there might even be some small prospect of avoiding Armageddon.

It is not so. Instead the rostrums are occupied by people who have nothing to say. The average conference speaker is either a self-enamoured myope who is so ignorant and bird-brained that he cannot appreciate the poverty and uselessness of his offering, or he is a cringing moral coward whose weakness of will stopped him from flatly refusing an invitation to speak. As a result he has had to pick through the rag bag of his mind in an attempt to find something—anything—to fill the programme time for which he has so faint-heartedly accepted responsibility. And (this is International Women's Year) for "he" also read "she". The rare soul who does have a worthwhile message to spread needs no conference to make his voice heard.

"So what?" you may say. "So long as they're happy, what's it to you? Leave them be, you sneering and cantankerous old spoilsport."

And so I would—and gladly—were the summer conference sport indeed no more than an innocent pastime for loose-enders and the self-important. Unhappily it is not innocuous. The speeches made, the papers read, and the resolutions passed lull all concerned (and those concerned are among our most caring and responsible citizens) into believing that *Something is Being Done*, and that *Progress is Being Made*, whereas, in truth, nobody is getting anywhere at all. Conferences are the opiate of the thinking classes. We had a World Population Conference in Bucharest just a year ago, didn't we? So that's all right. That particular problem is being seen to, isn't it?

No it isn't—no it isn't—no it isn't.

Donald Gould

## The last word on . . .

### Goals or gladiators?

This early in the football season comes further proof that in *Clockwork Orange* Anthony Burgess was forecasting rather than fictionalising. At the time of writing, loyal supporters of Chelsea had greeted the new season by stabbing ground stewards at Luton and stampeding through that hatter's castle like "demanded cattle, damaging cars, smashing windows and looting shops". Brian Mears, chairman of Chelsea Football Club, later pronounced that when he "Saw the incidents on the field at Luton . . . it was like being thrown back to the Middle Ages". I think he has a definite point there, but I don't think he really went far enough back in history to find the clue to the ultimate accommodation between our current civilisation and the neanderthal soccer fans. More rewarding, it might well have been, if he'd taken his allusion back to Ancient Rome.

It is painfully apparent that the hooligan fans travel to soccer grounds not to watch the football, but to indulge in primeval punch-ups with weekly-changing enemies. The 22 players themselves echo this spirit of parochial warfare as they compete in hacking shins, tugging jerseys, and abusing referees. While the remaining vast mass of the attendant crowd, feeling safe in the communal anonymity of the mob, applaud the efforts of their favoured ball-kickers at mayhem and vituperate bitterly any member of the visiting team who presumes legitimately to score goals against them. Just as with boxing, motor racing and "It's a Knock-out" many of the assembled spectators are psychologically attracted there by the possible sadistic satisfaction of witnessing serious injury, mental humiliation, or untimely death. Territorial imperative primitively brings others to the football stadium, the opposing team representing the wicked invader of tribal lands and the home team providing image-selves in heroic defence of hearth and home.

The illogical id-demands of all involved could be comprehensively satisfied if the Football Association recognised that history holds all answers and decreed that the inflated ball should be withdrawn, the 22 overpaid performers pensioned off and the thus available grounds be given over to those gladiatorial combats which so pleased the proletariat of Ancient Rome. Fair precedent for which could be taken from the triumph of Emperor Trajan in 2nd century AD when he had 10 000 gladiators butchering one another for public delight. Since our shreds of empire are at about the same point of decadence and decline, it would seem suitable to abolish the Football League and replace it for greater public good with the Gladiatorial League.

The same programme of fixtures could be followed, but the contest on the pitch would not be between 22 ball-kicking prima donnas, but would be a massed 90-minute, free-for-all punch-up between the youthful bully-boys supporting either club. The Chelsea Hooligans would do battle with the Liverpool Louts, and the

Manchester United Maulers could engage the Tottenham Toughs. Senseless violence would be taken off the high street and enclosed within the caged and moated confines of the football stadium. Instead of having to travel at their own expense in fragile railway trains, the visiting strong-arm lads would be picked up free by coaches and driven into pens constructed at either end of the ground. For one hour before punch-off they would be wine and dined on red meat and red biddy, and then released to meet the similarly-laced home-town ruffians at the centre of the pitch. Only firearms would be banned, and all other injurious aids such as steel combs, spiked boots, and bicycle chains would be accepted as fair play. To the encouragement of the crowd, they would be free and unhindered to fight, bite and smash up each other until the alsatian dogs announced half-time and the St John's Ambulance men came on to make emergency repairs.

They would then re-engage for the second half and, at the end of 90 brain-bashing minutes, a panel of doctors would tour the battlefield awarding points to either side—10 for an opponent killed outright, five for each broken limb, three for each unconscious opponent, two for a visible flesh wound, and one for every black eye.

Such delightful contests could go on throughout the season until all competing yobboes had crippled one another beyond recognition and into mutual extinction—a consummation for which all other soccer spectators would be ecstatically grateful.

Patrick Ryan

## Tantalizer

### No. 417 King Kong

This ancient Ethiopian game is a sort of Rugby football played with a melon. There are just two ways of scoring. By tossing the melon over a branch of your opponent's Haha tree you score a King, worth five points. By passing it through his ring of plaited Oomph grass you score a Kong, worth three points. If the match is drawn, each party collects an ox. Otherwise the winner gets two oxen.

Each of the four regions sends its champion to the annual Tourney of the Winds, where each plays a single against each of the others. This year 44 points were scored in total, of which North gained 10, East 15 and South 11. 13 points were scored against North and 9 against East. South drew at least two matches and no two teams received the same number of oxen.

What Kings and Kongs were scored in the match between North and West?

Martin Hollis

### Solution to Tantalizer No. 416 Prior arrangements Four

The first bell would summon anyone who could see 10 red or 5 blue. Knowing this, either 2 blue (if there are exactly 2 blue) or 7 red (if there are exactly 7 red) will leap out at the next occasion.

# Review

## The ignorance explosion

by Professor Cyril Darlington FRS

### Man and natural resources

An agricultural perspective  
by Sir Cedric Stanton Hicks  
Croom Helm, pp 122, £5.25

During his last thousand generations man has gained control of nature and colonised or occupied the Earth. This is well established. It is not so clear how important or inevitable are two kinds of effect which seem to have accompanied this success. One is specific, chemical and irremediable: the depletion of certain resources which man has found useful. The other is general, biologically connected and largely irremediable: it is the degradation of man's natural environment. These processes together, it is held, are now approaching the limits of what man can do and what men can bear, since occupation is nearly complete and degradation or pollution threaten widespread disaster. Moreover, for the first time in history, a large part of mankind, the source of these ills, is multiplying, and even being helped to multiply, uncontrollably. Hence these dangers seem to be converging on us at the same time.

We are familiar enough today with generalisations of this kind but their value and their consequences are much disputed. Any man who is to assess them needs to have experience of agriculture, medicine and industry in different parts of the world. He also needs to have combined this experience with a deep historical understanding. It seems to be just the possession of this equipment that has driven the author to write this book. *Man and Natural Resources* is packed with information on the history of agriculture and the stages by which human invention, first technical then industrial, has turned the cultivation of the land into a means of destroying our habitat, our society, and ultimately our natural resources as well.

Some serious observers may have thought that the prophets of doom in recent years, whether economists, statisticians or naturalists, have been unduly dismayed by what may be merely transient circumstances. It is therefore most useful to have a long-term study of a region which the author knows particularly well, namely Italy. He shows us how the political, agricultural and medical conditions of this country have interacted over the last three millennia. With this perspective we can begin to compare the age-long extension of the Sahara, the shifting famine of the Sahel, and also the swift disaster in Australia, described by the late Francis Ratcliffe under the title of *Flying Fox and Drifting Sand*.

Cyril Darlington is emeritus professor of botany at the University of Oxford

Throughout the range that we know in time and space, and in evolution from savagery to civilisation, men have been taking the cash and letting the credit go.

Among several scientific and philosophical ideas that Sir Stanton Hicks discusses the most urgent is the view that economists and politicians have relied on scientific assumptions which are now obsolete. They have used them to drive forward an optimistic competitive development of man and the Earth. It has been, in Hicks's terms, an ignorance explosion which has forced us on a disaster course. The notion that nothing is impossible for science which seized the imagination of Marx, Engels and Lenin is the same notion that later gripped the corporations and finally the trade unions of the capitalist world. Now it has become the great world belief, the saving superstition, the cargo cult, which underwrites the whole machinery of man. Just at the moment when scientists have found it to be fictitious.

Connected with these problems is the question whether, as Hicks puts it, man has a limited intellectual capacity. Here we meet our author's one blind spot: he overlooks the genetical view that individuals differ, the capacity of one is limited but the capacity of many has no known limits. The limit that we cannot escape is not in man but in the Earth.

This is an important book and it is therefore a great pity that the publishers seem to have thought it superfluous to have the proofs corrected. The hundred mistakes that consequently appear in print include some that will perplex the careful reader. Surely Ricardo's Law of Diminishing Returns (p46) refers to increments not implements of labour? And surely Goethe (p1) did not invoke the "eyes of Prosperity" which has no eyes? It was the eyes of Posterity that he, like us, had to fear.

### How like an angel

Biology and the nature of man  
by Jonas Salk, planned and edited by Ruth Nanda Anshen

David and Charles, pp 118, £3.50

The first part of the title of this book is taken from Rosencrantz's eulogy of man and his capabilities in Hamlet (act II, scene ii). Jonas Salk, the originator of the first successful vaccine against poliomyelitis and founder of the Salk Institute, also admires and warms towards man. But Rosencrantz went on to say "and yet to me what is this quintessence of dust? Man delights not me; no, nor woman neither." Perhaps Salk should have continued the quotation, because he is disturbed and basically pessimistic about the way in which the human race

persists in doing things of which he, as an educated and enlightened American, disapproves, and which he thinks—perhaps rightly—may lead to its self-destruction. Why, he asks, with all the physical and intellectual opportunities available, does man (should he not rather think of individual people, societies, governments and power groups?) indulge in war and violence, pollute and spoil the environment, and recklessly use up precious and irreplaceable natural resources? These are fair questions which exercise the minds of many ordinary people, as well as of professional sociologists, economists, philosophers, political theorists, theologians and the rest.

Salk's answer appears to be that if only people understood evolution and biology as he does they would behave sensibly. To help them, he—or Ruth Nanda Anshen, who is not identified but is presumably a disciple or amanuensis who has sat at his feet and listened to his words of wisdom—has set out in 118 pages a series of analogies between biological phenomena and human behaviour which might provide a basis for ethical standards and "sensible" conduct on our part. These analogies include the varieties of the immune response as examples of human tolerance or intolerance ("allergy") and of memory and learning processes; induction of adaptive enzymes in bacteria by other substrates as illustrations of the need for environmental stimuli to evoke the potential responses and capabilities of a developing child; biological survival value, as illustrated in the evolution of species (omitting, unfortunately, to stress the importance of selection, and failure even more than success, as the most powerful directive force) as an example of the need to make responsible individual and collective decisions about reacting to the present-day environment; immunological hypersensitivity and auto-allergic reactions to illustrate how a society's over-reaction against drug-taking by adolescents may turn them into criminals; solution by semi-permeable membranes as a model for the making of value judgements. These are only a selection.

Jonas Salk is clearly a humane, though troubled and somewhat pessimistic, person and his intentions are of the best. He writes:

"Our present state of advancement and unification of knowledge is such that it can reasonably be said that the generation now entering adulthood is the first to be in a position to draw upon sources of knowledge and inspiration to build a philosophy based on the operation in man of biological laws. When understood, these laws will provide a basis for the better use of man's power of self-development for ends which may be individually and collectively satisfying, although many problems will no doubt continue to confront us."

Although an Athenian of the age of Pericles might well not have accepted this statement, the French Encyclopaedists or even T. H. Huxley might have made it of their own contemporaries. The Age of Enlightenment does not, how-

ever, seem to have arrived, and I doubt whether *How Like an Angel* will bring it much nearer. To the biologically educated the biological facts quoted will appear as truisms but the analogies often as woolly or false; while, for the uneducated the examples are insufficiently explained to give them insight. Although it may seem unfair to quote out of context, the following paragraph is not atypical nor particularly enlightening:

"We see the continuum from molecules to man, and we see evidence of the operation of forces which increase in complexity and intensity with the ultimate emergence in man of 'will' and of 'choice'. It is as if the life force itself, whatever it may be, had evolved in time in a way that could not have been predicted prior to the emergence of the many forms in which it exists. This would include 'man's will', which may be looked upon as an expression of the evolutionary development of the 'insistence' of living things to survive. We shall not try to analyze further 'man's will', or the 'insistence' of living things to survive, but shall merely accept its existence and try to understand the forms that it has taken and the effect this has with respect to human choice."

In attempting to write a short ethical treatise without evidently drawing upon religion or philosophy, or considering the explanations of different aspects of behaviour proposed by Marx, Freud, or modern anthropologists, Salk undertook a formidable task. Other writers who have set out to derive a justification or explanation of ethical behaviour on the basis of current fundamental biological science (eg C. H. Waddington's *The Scientific Attitude* in 1941, or even Jacques Monod's more recent *Le Hasard et la Necessite*) were more modest—and more readable. John Humphrey FRS

#### The futurological congress

pp 150, £2.90

#### The cyberiad

pp 296, £3.90

by Stanislaw Lem  
Secker & Warburg

#### The science fiction book

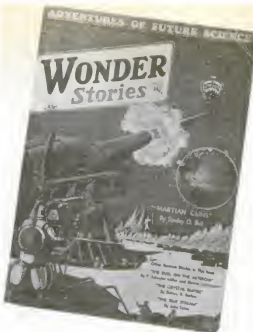
by Franz Rottensteiner

Thames & Hudson

pp 160, £4.95 (£2.50 paper)

Some years ago, before Tsarkovsky's film, a friend told me I should familiarise myself with the works of a brilliant Polish science fiction writer called Stanislaw Lem. As a result, I read *Solaris*, a novel which has become much better known since the release of the Russian film version, but perhaps not more widely read; I found *Solaris*, as a book, a profoundly boring experience. Reading it had, I felt at the time, provided me with enough Lem for life.

Having now read *The Futurological Congress* and *The Cyberiad*, I am glad I overcame my reluctance to read more Lem. These books offer a completely different perspective to that of the turgidly serious *Solaris*. Both are satirical, and fantastic, reminding one in



Cover illustration to one of Hugo Gernsback's (1884-1967) journals

parts of Swift, Voltaire, Borges, and Iif and Petrov. However, all these writers have or had a power that Lem lacks. If one is writing fables, should they not have a moral or three? Amusing fantasies, well stocked with linguistic invention (credit for which must presumably be at least shared with the translator, Michael Kandel, who has produced some splendid English word-plays), these Lem-books largely lack lemmas. Perhaps, in 20th century Poland, it is not wise to be as acid about the human condition as Swift and the others were in their times and places.

For a modern example of where I feel Lem falls short, compare his account of how a civilisation of the Highest Possible Level of Development behaves (in the

story "Altruizine" in *The Cyberiad*) with Borges story "The Immortals". Nevertheless, the books contain some very entertaining material. My favourite is the extended analysis of dragons, which puts them into the same category as electrons, thus explaining why many people do not believe in them (*The Cyberiad*, pp 85-102).

In *The Science Fiction Book*, Franz Rottensteiner calls Lem "the greatest contemporary SF writer". Clearly, I would not go that far; but then, many of Rottensteiner's views are quaint. His book is one of those compilations where, one feels, the author has been asked to write seven and a half metres of text, because that is how much space is left between the pictures. As a result, the illustrations—where they have not been printed in absurdly sub-visual tints—are more interesting than the text. Most of the latter is the sort of prose that one finds increasingly nowadays on the backs of potato crisp packets, or beer mats, or matchboxes, as part of a series—a thousand useful facts about birds habits, historic towns, hedgerow plants or, in this case, science fiction.

The book is divided largely into sections in which the text of each would probably have fitted onto a beer mat (if it had been sympathetically sub-edited). Even when read from front to back, the book induces the same feeling of disjointedness one gets when one's second packet of crisps has part 39 of something informational on the back, which juxtaposes badly with the first packet's part 8. Thus, after "chapters" dealing with John W. Campbell Jr, Olaf Stapledon and C. S. Lewis, we timeflip back to Jules Verne, and then to Cyrano de Bergerac.

*The Science Fiction Book* is saved from utter disaster by the good selection of illustrations, and a brief survey of science fiction outside Britain and the North America. Martin Sherwood

#### Random vibrations and spectral analysis

by D. E. Newland  
Longman, pp 286, £6.95

Ten years ago few undergraduates studying engineering or applied science would have been instructed on the subject of random vibrations. Nowadays almost every applied scientist needs at least some familiarity with the concepts and methods involved.

We are surrounded by examples of random vibrations, a leaf fluttering in the breeze, the movement of a car over a bumpy road, the movement of a bridge under the load of passing traffic. All are characterised by their essentially unpredictable nature, and yet in many cases it is of paramount importance to be able to predict the behaviour of such randomly vibrating systems—to calculate the maximum dynamic stresses likely to occur in a bridge for example. It is possible to calculate the average movement or response to be expected and the theory of random vibrations is concerned with making and interpreting these calculations.



Art of Hannes Bok, whom Ray Bradbury claimed was one of SF's best fantasy artists



The first part of this book deals with the fundamental concepts of one dimensional random process theory. It demonstrates how the statistical characteristics of the response of linear systems depend on the statistical nature of the excitation applied.

The second part of the book is devoted to digital spectral analysis and deals with methods of analysing experimental records of random processes with the aid of a digital computer. The discrete Fourier transform and its computational equivalent the fast Fourier transform (FFT) are discussed in depth. This in-depth treatment is particularly welcome because with the ever increasing use of computers for data analysis many people find themselves using the FFT for spectral analysis without a complete understanding of the approximations and limitations involved.

An important feature of the book is a set of problems and answers. Most of these have been designed to illustrate points in the text and they serve the dual purpose of both testing the reader's understanding and illustrating applications that could not be given an in-depth treatment. The text is, understandably, fairly mathematical. However, the treatment has been kept as simple as possible and is certainly within the grasp of final year students of engineering and applied science. The text is further supported by references to other more specialised and up-to-date literature to help readers who wish to pursue the subject further.

In general the book is well written and well illustrated. It should appeal not only to undergraduates but also to engineers who have never had formal instruction in the analysis of random processes but who are increasingly likely to need a working knowledge of the subject.

Colin Roberts

## Minamata

by Eugene and Aileen Smith  
*Chatto and Windus, pp 192, £7-50*

The Chisso corporation was responsible for poisoning the inhabitants of Minamata with mercury effluent from its factory. When a respected and well known American photojournalist took up residence in the town to record this "warning to the world", he was set upon by thugs. "Chisso", he claims, "had set us up—they, by damn, were going to intimidate the patients and take care of that foreign journalist." In the punch-up Smith was beaten-up so badly that his sight was seriously impaired.

This was a more serious accident for a photographer than for perhaps anyone else. And yet W. Eugene Smith did not want what had happened to him to detract from the plight of the people of Minamata. "I decided not to sue. I could not be both plaintiff and journalist."

Smith is no ordinary journalist. Not only does he match words and pictures—doing both with powerful simplicity—he also eschews the easy headline in favour of true insight. While environmental journalists—and other anti-technology writers—were running around digging up new, and mostly unproven



**"Without question!  
The chemical company called Chisso  
poisoned the fishing waters of  
Minamata, poisoned the aquatic food  
chain, and eventually poisoned a  
great number of the inhabitants. Chisso  
poured industrial poisons through  
waste pipes until Minamata Bay was  
a sludge dump, the heritage of  
centuries destroyed."**

horrors, Smith and his wife persisted with a story that was nearly 20 years old. And theirs is no simple minded, black v. white tale of corporate evil inflicted on an innocent population. Minamata earned prosperity through Chisso. And it was not, until very recently, in the Japanese style to question the behaviour of the large corporations.

The Smiths' book gives an insight into the Japanese mentality through its account of the Minamata incident. It is also a powerful comment on the new "technological ethic" that environmentalists are forcing on the world. Words and photographs are inseparable in their narrative. "Historians might find in Minamata the healthiest roots of a new industrial revolution. Looking back, they might find that from this arena emerged the strongest realisation that industry has no divine right to pollute in the name of gross national product. They might find—if humankind ever decides to assume true responsibility for its stewardship of this planet—that they are looking back into a kind of soul-force of courage, a force that might save our children from the plunders that began with the first industrial revolution."

Michael Kenward

## Bumblebees

by D. V. Alford  
*Davis-Poynter, pp 352, £25-00*

This is the third book, written in English, that is devoted solely to bumblebees, since F. W. L. Sladen in 1912 produced his classic *The Humblebee and How to Domesticate It*. However, the fact that the previous three books are now out of print would seem adequate reason alone

for the production of another, especially as bumblebees are important pollinators, and Alford has presented us with a competent up-to-date review of most aspects of the literature.

After a useful and informative introduction to the physiology and morphology of bumblebees, this book, in common with its predecessors, contains sections on the founding and growth of the colony, activities of worker bees including foraging, the production of males and queens, enemies of bumblebees, finding and collecting colonies, keeping colonies in artificial nests, classification and identification.

The present volume reflects the additional work during the last decade or so on the enemies and nest commensals, hibernation of queens, scent marking of male flight paths with mandibular gland pheromones, heat production, and the feeding and development of bumblebee brood. Most readers will find much that is fascinating and new. Despite recent experiments and observations it is apparent that we are still uncertain of the factors responsible for the change from worker to queen brood production. Indeed, because there have been few advances recently in many aspects of bumblebee biology, it is inevitable that even some of the descriptive phases used have a familiar ring. I personally would have liked to see more discussion of the foraging behaviour of bumblebees and their role as pollinators of agricultural crops; it is only by a deeper understanding of their biology that full use will be made of their pollinating potential.

A feature of the book is the inclusion of distribution maps of the British species, based on records made by Bee Research Association members in collaboration with the Biology Records Centre and in which Alford played a leading part in organising.

While the book is profusely illustrated, I question the need for many of the 68 black and white and 26 colour photographs, which have often been printed below the standard of quality that is now usually regarded as acceptable.

John B. Free

## Bookwatch

by Al

### The cost of perfection

For the third time in six weeks a dangerous error in a book has been responsible for a publisher rushing notices to bookshops to safeguard the buying public. In the first week in September Fleetway Annuals, a division of IPC, was forced to call in copies of *The Look and Learn 9th Book of Wonders of Nature*. The error was in an article on mushrooms and toadstools which, if believed, might have caused a death. As a result of a typographical transposition the reader was shown a picture of the death cap toadstool, and told in a caption that it was "harmless". The publishers, acting with commendable alacrity, urged booksellers to get returned any sold copies—and, by way of an incentive, warned that "the death cap toadstool is 95 per cent fatal if eaten".

Reporting all this in its 6 September issue, the *Bookseller* reminded its readers that back in July it had issued cautions concerning two other books. W. B. Saunders was having to circulate erratum slips for a serious drug-dose error in its just published 14th edition of Cecil and Loeb's *Textbook of Medicine*, edited by Beeson and McDermott. Then because there could be "dangerous consequences" from use of a table concerning chemical combinations in the third edition of

Smith and Van Ness's *Introduction to Chemical Engineering Thermodynamics*, McGraw-Hill, the publishers, had prepared an erratum slip, and the *Bookseller* warned that in no circumstances were copies of the book to be sold without it.

While it is likely that such startling errors as these are no more common now than in the past, I get an uneasy feeling about the crop of minor errors and transpositions that nowadays plague all sorts of publication. However, from the very complex nature of their production, I don't suppose that there ever has been a book without some minor error—be it ever so small. A friend who spent all his working life in publishing, and also managed to write nineteen books, once claimed that the first thing he invariably saw on opening a mint copy of his latest work was an error. All this after painstaking reading of the manuscript and proofs, and with a printer and publisher of high repute. When later I proudly opened the complimentary copy of my first book, horror, horror, there it was in the middle of the page "element". Even later when, as a publisher, I presented an eager first author with a crisp new book straight from the binders' packet, it raised a gasp. "They've not printed some of the pages". One of the large pieces of paper that go to making a book had been printed only on one side. Fortunately the next hundred or so copies that we sorted through were in good order . . . but it was a nasty

moment for me.

These incidents happened some years ago when publishing seemed to be publishing, and before printers became vulgarly cost conscious and books astronomically expensive. It was a time when both printer and publisher provided a true service to writer and reader. I'm not suggesting that they don't do so now—they do if they are any good. Take the printer, for example. He will now cost out most carefully his time and effort in achieving "perfection"—and charge the publisher accordingly. Typesetting and page preparation are labour intensive activities, while printing and binding, to be economic, involve keeping machines fully active (you pay if you keep them waiting). Both the typesetters and the machines must earn their keep. If they don't the printer goes under. The question for the publisher nowadays is how much "accuracy" he can afford to pay for—and pass on to the purchaser. It explains why even *The Times* is riddled with literals as never before, and why last week *The Guardian* published the amazing revelations of a scheme that would have "hit employers who made people over 5 redundant . . ." We've probably got to live with errors in our newspapers because we're unlikely to be prepared to pay for them to be "cleaned up". But with technical and reference books now costing somewhere between £8 and £25 (and the £100 book is likely not far off) surely we have a right to expect an error free product?

## Art

### George Rickey: mobile sculpture

Gimpel Fils Gallery, 30 Davies St, London W1 until 27 September

Rickey, who was born in Indiana almost 70 years ago and read history at Balliol, has never exhibited in Britain before. This loss is now partly remedied. At Gimpel Fils he shows between 30 and 40 mobiles, which, born of skill and ingenuity, are, one and all, objects of sheer delight.

Almost all of them were made during the past three years. They are all made of stainless steel, and broadly divisible into two groups, depending on whether they are to be kept in or out of doors. Alexander Calder has looked on mobiles as suspended planes, and William Pye (*New Scientist*, vol 58, p 512) lets the wind sing through his suspended rods. Rickey also uses the wind (or else electric fans, thoughtfully provided by the management), but the surfaces he uses are few and far between. The reason is that he has programmed his mobiles to describe them by the paths determined by the position and inclination of the fulcrums about which the carefully balanced objects gyrate. The objects, incidentally, are often foils which a fencer might use, swirling one through space to mislead his opponent before delivering his final thrust, or again perhaps like a conductor's baton, conveying mood while dictating rhythm.

The intrinsic heaviness of the steel is

contrasted by the precision with which Rickey has achieved the balance. The centre of rotation all but coincides with the centre of gravity so that the merest breeze can act.

Where these mobiles differ fundamentally from Calder's better known coloured slabs is that the latter hang, whereas Rickey's are suspended. This means that Rickey can allow his Two Lines Up Excentric to gyrate next to each other without one being able to collide with the other, a point repeated with Two Open Rectangles Excentric.

However, it is not only elementary geometry that inspires this artist. He echoes aerials and rotors, even gills. As



he is only too well aware, he follows in the footsteps of the Russian constructivists of the 1920s and the early 1950s, and is interested in "nature" without wishing to reproduce or to represent it. "If I have any inventive capacity", he writes modestly, "it is maybe in that direction that I'll think up a way in which I can quickly test a feasibility. The soundness of the idea then comes out fast. I will know whether it's worth going on." This neat experimental approach is also manifested in the more intimate indoor sculptures, some of them unfortunately gilded. This vulgar trait does not strike me as a telling selling point: it is not the shape of the mobiles that is decorative so much as their movements. For this reason high polish is greatly to be welcomed, and to hell with the gold.

There is another dichotomy in these sculptures, which, precisely because of the very subtle kinetic principles that underlie all of them, is hard to grasp in purely physical terms. It is as though some of them were active, others passive, in some the muscles are flexed for action, while in others they are flaccid to be done to whatever an external motive force may be programmed to do. Perhaps some were conceived in the morning, and others at night, or perhaps the duality is expressible in physical terms after all. The items that strike me as active are those with low frequencies of action, whereas the passive ones cover a higher frequency-band, and because of the smaller moments of inertia of their components, are more readily subject to rapid random changes.

Robert Weale

# Letters

## Depression

SIR.—Reading Dr Cuthbert Watt's excellent article ("Depression—the root causes", 4 September, p 531) I was struck by the analogy, as social phenomena, between mental illness and dental illness. Both are far too prevalent in modern society; both result from a multiplicity of causes, not completely understood; both consume a great deal of professional time, and cost the community a lot of money; both produce symptoms varying from acute distress to chronic misery; both result in incapacitation out of all proportion to the apparent cause; and finally either, in the complete absence of medical science, could cause death.

It is in the prognosis that the analogy breaks down. Dental trouble is readily and permanently curable; mental trouble is not.

I have personally known three severely depressed people; one man and two women. The man, a colleague in his middle 40s, committed suicide by hanging, leaving a widow and two children. During the six or so years in which I knew him, he had several doses of ECT, was permanently on drugs, and was continuously monitored by the local psychiatric hospital; he had, in short, the best care presently available. His trouble apparently started many years before, in his late teens or early 20s, at the beginning of a promising academic career. His suicide, a wretched barbarous end to an unhappy life, was the last of several similar attempts.

Of the women, the first is in her early 30s and lives with her widowed mother. She had a "nervous breakdown" some 15 years ago when her father died, was in hospital for a time, then at home, helpless as a child. She has recovered sufficiently to work in the nursery department of the primary school where her mother teaches.

She is permanently on drugs and has mild anorexia and moderately severe agoraphobia, seldom venturing far from

her mother's side. Some seven years ago she seemed to be gaining self-confidence, and was enrolled on a SEN training course at a hospital a few miles away, but came home after only one night and resigned the course. She then obtained a job as wardmaid at a hospital about a quarter of a mile along the road from her home, but even that amount of separation from her mother proved too much for her. Provided her mother is within reach she is reasonably happy, but she is entirely dependent upon her mother's moral support, and dare not sleep unless her own and her mother's bedroom doors are open.

The second of the women is just 30. She had a "nervous breakdown" in her final year at school, was in hospital for nine months, and had 20 doses of ECT. She lives alone in a bed-sitting room and has a fortnightly injection and tablets four times daily. She has never had a regular job, but lives on Social Security. Her world consists of her room, the supermarket, the general practitioner's surgery, and the local church where she sings in the choir and enjoys a "crush" on the organist. She is so lacking in self confidence that when her injection falls due she usually stays awake all night in order to be in time for her appointment—1100h the following morning, in a surgery about 100 yards away. She is known to weep for hours over an imagined slight.

Dr Watts, in his last paragraph, considers whether or not depression serves any useful purpose. He concludes that it does not, but is an unfortunate side-effect of our increasing intelligence and sensitivity. Could it not also be, paradoxically, a by-product of our improving medical science and our heightened social concern? Presumably in a society devoid of either, both mental trouble and dental trouble would be eliminated by natural selection. The teeth of both Esquimaux and tribal Africans are proverbially magnificent. In the case of the Esqui-

maux this is usually attributed to a sugar-free, protein-rich diet, but this cannot be true of the Africans, whose diet contains a high proportion of carbohydrate. Can it be due to natural selection?

The traditional function of medicine in society is the preservation of life. This was logical enough when mankind was struggling to survive as a species, but that time has long since passed. Is it not high time to reconsider? A more logical emphasis nowadays would be not the preservation of life but the alleviation of suffering. My colleague solved his problems in a logical but regrettably barbarous manner; the two women may be accurately described as condemned to life. To turn to the analogy, the present-day treatment of both mental and dental illness consists of patching-up and propping-up. Some time ago a contributor to *New Scientist* (vol 57, p 29) suggested that a proper, biological approach to dental care would be a planned programme of extractions. I suggest that the proper, biological and humanitarian approach to mental illness is the ready availability of voluntary euthanasia.

I confidently await the hailstorm of emotional/abusive letters which the word "euthanasia" inevitably provokes. I confidently predict that they will all miss the point; they will attack me for things I have not said, and for views which I do not hold; they will call me a monster or a Nazi; they will ask me who is to make the decision; and they will accuse me of wanting to play God. Incidentally, if driving a knife or an electric current through somebody's brain is not playing God, I should like to know what is.

L. E. Ambrose

107 Sturton Street  
Cambridge CB1 2QG

## Communications

SIR.—I have long thought that attempts to discover communications by other galactic civilisations are centred much too narrowly on current radio-telecom-

## Grimbledon Down

Bill Tidy





munications practice, and that more brute force methods are preferable. Hence my early naive idea (not unconnected with idealistic visions of world disarmament) of launching all the H bombs now stockpiled to a suitable distance from the sun, and exploding them in a coded sequence.

But how much better it would be to pulse the output of a star itself! Your account (Monitor, 31 July, p 254) of the rapid (on a cosmic timescale) oscillations of the X-ray source Cygnus X-1 raises the possibility that something like this is being done, and I suggest that we may well find that either the outputs of Cygnus X-1 or some similar object are being intelligently modulated. The modulation period of tens or hundreds of days may seem long to our human centred viewpoint, but if one intends to transmit across thousands of light years does it matter if the message is 10 years long?

The potential range of such a system is very large, since extra atmospheric observations could easily resolve the signals at intergalactic distances.

Dick Jackson

1461 Second Street  
Manhattan Beach  
California  
USA 90266

### Mencher's meaning

SIR,—I think I understood Dr Martin Sherwood's review of Alan Mencher's study ("SOS: no answer to a cry for help", 21 August, p 416). I even think I agreed with it, particularly as summarised by the cynical quote from Ivan Illich: "The cure for bad management is more management". But Mencher's description of the 5-stage process contains Item 3—"the scientists and technologists) discharge their task by locating and removing obstacles to the implementation of the identified technology and/or improving or creating an appropriate environment, or causing it to be created". At this point uncertainty sets in. Does this mean what it says? No, the question is what does it say? Is it naive of me to think it says: "they try to overcome the problems?" Any deeper meaning escapes me.

Could this be another manifestation of a different effect, the "Dollars per Word Syndrome (DPWS)"? Later in the article this view was confirmed by the following passage (with my interpretation in brackets). "The effort in this field failed to produce the results for which it had been conceived" (They failed) "and government support of the programmes designed to achieve those results was terminated after periods of varying duration" (and government support ceased). Alan Mencher is a visiting fellow at the London Graduate School of Business Studies. My confidence in his analysis would be greater if he applied a little time-and-motion study to his own writing. Dr Sherwood summarises that "any coherent professional group tends to overrate its own importance". He should not have confined his remark to the coherent groups.

D. H. Mash

78 Upper Park  
Harlow  
Essex

### Skyship

SIR,—Some of the claims attributed to Major Wren by Tim Eiloart (Venture, 4 September, p 546) require comment.

He did not talk to "all lighter-than-air groups"; neither Aerospace Developments nor Airfloat Transport have any record of contact with Wren's outfit, though these two companies have made most of the UK running in serious airship studies since 1970 and have both developed viable solutions to ground handling problems with conventional configurations.

Photographer's feet and oracular hair-driers are equally devoid of relevance to the fundamental instability in pitch and roll of the Skyship geometry, demonstrated by the Cranfield tunnel tests and by other authoritative experiments. Some pendulum alleviation may be achieved at low speeds through an underslung payload, but not even the most optimistic estimate of metacentric height can confer stability upon the full-scale Skyship with a 400-tonne load at speeds greater than about 30 km/h, a little more power 'would have convinced even Major Wren that the threshold speed of the Cardington model was only fractionally beyond that of its wavering drift through the hanger.

It is difficult to visualise the circumstances which would cause a Skyship to lose all its gas at altitude, but if it did so the subsequent descent would be rather less than Wren appears to hope. Its instability would induce a sequence of falling-leaf swoops of increasing ampli-

tude, terminating at the ground with a tangential velocity of heroic magnitude.

The airy variety of structural arrangements proposed for the ship implies that insufficient work has been done on any of them, either to select an optimum or to substantiate the claim that the geometry offers better stress characteristics than does the traditional form; inspection of the only published information casts doubt upon the integrity of the structure under reversible loading by the weird ground handling system.

The Skyship can be made technically, if not commercially viable; the project has simply exchanged the known problems of traditional airship forms for the unexplored characteristics of a dramatic new configuration, and these may eventually be brought to heel through lavish application of time and money. Until a lot more work has been done, however, Major Wren should note that Tim Eiloart's analysis of credibility describes psychology as a partner of technology, not as a replacement for it.

Edwin Mowforth

The University of Surrey  
Guildford  
Surrey GU2 5XH

### Round Island mammals

SIR,—J. R. Bareham (Letters, 4 September, p 553) obviously has no idea of what conditions on Round Island are really like.

If the use of strychnine can be justified for the control of moles in the UK, surely it would be much more justified for the

# Subscribe

The most convenient way of buying New Scientist is by direct subscription. Use the coupon to order, then copies will arrive each week by post. Please send payment with order. Cheques payable to New Scientist.

Publisher's Subscription Rates	1 year
UK	£15.10
Overseas surface mail	£16.40
US and Canada (airfreight)	\$44.30
Airmail Rates	£34.40

For a subscription with index, add £1.20 to the annual rate

To: New Scientist, 128 Long Acre, London WC2E 9QH, England

Please enter my subscription for ☐ 1 year ☐ 6 months

☐ with index. I enclose payment of \_\_\_\_\_

Name \_\_\_\_\_

Address \_\_\_\_\_

eradication of a dozen goats and a few thousand rabbits on Round Island in the interests of science. I suggest that the shooting of these animals is much more cruel and inhuman than the use of quick-acting poisons, including strychnine, as they are seldom killed outright, even by "skilled marksmen" (the terrain being extremely rough), and may suffer agonies for hours or days before eventually dying.

Mr Bareham's statement that "this (mammal) population would be worth preserving if the rabbits are a snake-eating variety" must surely be an error. Do any rabbits ever eat snakes? The two unique and very rare species of snakes (living fossils?) are among the most interesting features of Round Island, whereas the mammals are introduced pests which should, indeed must, be eradicated by almost any means before it is too late (ie, very soon).

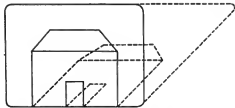
N. R. Brouard

Péreyère, Grand Baie  
Mauritius

## TV illusions

Sir,—I have noticed the following optical illusion for many years but, on asking acquaintances on various occasions, have never found anyone else who can experience it. I wonder if any of your readers have noticed this and can explain it.

While watching television at a distance of 10 ft (none of these distances is critical), I fix my eyes on a point 4 ft or so to the left of the screen. I then rapidly flick my eyes to a corresponding point to the right of the screen, causing my eyes to scan the picture without consciously looking at it. I then get a fleeting glimpse of the picture distorted as in the diagram. If, for example, a house is shown, then the dotted line outlines the illusion of the screen with the picture. That is, the upper



part of the picture is displaced to the right but the base remains *in situ*. Conversely, if my eyes are moved right to left, the upper part is tilted to the left but the base again remains fixed. The quicker the movement, the greater the tilt.

Philip N. Cowen

The University of Leeds  
School of Medicine  
Leeds LS2 9NL

## Glass fibre dangers

Sir,—The warning by Professor E. J. Shellard, that in the future glass fibre may rival asbestos as a cause of lung cancer (Letters, 24 July, p 231) is very timely, but the possible dangers can be specified a little more precisely in the light of available evidence. As regards ordinary glass fibre or old fashioned glass wool, the fibres are so thick (15 micron) and inflexible, relative to asbestos, that the risk of inhalation must be correspond-

ingly low. Moreover, in contrast to asbestos fibres, neither glass fibre nor glass powder give rise to mesothelioma when inoculated intrapleurally into rats (M. F. Stanton and C. Wrench, *Journal of National Cancer Institute*, vol 48, p 797, and J. C. Wagner *et al*, *British Journal of Cancer*, vol 28, p 173). The same applies to *in vitro* tests: asbestos produces chromosome damage to cultivated cells within 48 hours, while ordinary glass fibre and powder do not (see A. Sincok and M. Seabright, *Nature*, vol 257, p 56).

However, finer glass fibres are coming on to the market. One of these is popular as a laboratory filter (code names AAA, GFA or 106). This fibre (AAA, diameter 0.5 micron) has been found to resemble asbestos in carcinogenicity, when implanted into rats (see Stanton and Wrench). The reason for the enhanced carcinogenicity of finer glass fibre is not known at present, but the fact that they would be thin enough to enter the cell raises the possibility that they might upset chromosome distribution, like asbestos above (see Sincok and Seabright). A super fine glass fibre has recently been introduced into Britain (code 100, diameter 0.05 micron). I do not know if this material has been tested for carcinogenicity, but my *in vitro* tests showed it to be comparable with AAA as an inducer of fibroblast growth (*Experimental Cell Research*, vol 81, p 104). There appears to be some correlation between this *in vitro* growth test and *in vivo* mesothelioma introduction in rats (see *Lancet* 1973, vol 1, p 807).

More data are obviously required on the inhalation characteristics of various glass fibres, relative to asbestos. Also, it would be desirable to know whether superfine glass fibre causes chromosome abnormalities in the rapid *in vitro* test (see Sincok and Seabright). However, pending the results of such tests, I should be fairly happy about continuing to use common glass fibre for insulation or repair at home (with normal precautions against irritation by siliceous particles). But in the laboratory I should be inclined to treat the superfine materials (which seem less irritating than glass wool) as carefully as if they were asbestos, until more is known about their toxicology.

N. G. Maroudas

71 Park Avenue North  
London NW10 1LE

Sir,—Professor Shellard makes assumptions which are not supported by the facts. His anxieties are no doubt prompted by the reports of mesothelioma production following the surgical implantation of a variety of fibres, including asbestos and glass, into the pleural cavities of rats.

Glass fibres have been manufactured in Britain for more than 40 years and despite this long period of observation no case of mesothelioma, no increased incidence of lung cancer and no fibrotic disease of the lung similar to asbestosis have been found. It is wrong, therefore, to say that glass fibre and asbestos must behave in the same way.

In the animal experiments it is only the fine sub-micron fibres which are impli-

cated, and the majority of commercial glass fibre is well above the respirable range.

Despite the complete absence of fibres in any human involvement, in view of the above experiments and the steadily increasing use of all forms of glass fibres, the industry is not being complacent. The not inconsiderable medical research over the past 40 years is being intensified, internationally, to ensure that no possible health hazard is overlooked. W. Snowden Fibreglass Limited  
St Helens  
Merseyside WA10 3TR

## Mammals on islands

Sir,—Besides the silly wording "alien sheep" in its introduction, Dr Bill Bourne's article (21 August, p 422) is so full of holes that it is difficult to know where to begin correcting it.

The Soay sheep on Hirta were not "left behind after the evacuation"; they were placed there, presumably in an attempt to ensure the survival of what many people would regard as an extremely interesting, in effect, wild animal.

It is a gross distortion to say that "all accessible surface had been grazed bare, to form a green lawn", etc. In fact, in common with, for example, most hill farms in this country there is a large over production of vegetation in the summer, and about half the island is covered by heather-dominated communities.

What is "tussock-grass"? There is no British species given that name. Tussock grassland is a form widely used in New Zealand to denote communities dominated by a variety of species. Why make the comparison—surely of limited validity—with New Zealand? Why not with other British sub-oceanic islands, notably Dun, itself in the St Kilda group, which has never been more than lightly grazed and not at all in the past 100 years?

The suggestion of sheep treading in puffin burrows on Hirta is ridiculous. The main puffin colonies in the St Kilda group are on Soay and Boreray, where they have co-existed successfully with sheep for centuries, and on the ungrazed island of Dun. On Hirta, puffins nest mainly in large boulder scree, often in areas inaccessible to sheep.

It should be emphasised that if anything the vegetation of Hirta is more akin to that of the Western Highlands today than it was in 1930. In particular there has been a large expansion of heather, indicating that the Soay sheep have actually had less impact on the vegetation than the preceding Blackfaces. This argument is expanded in the reference given by Dr Bourne.

It would not only be a pity to remove the Soays from their native island. It would be a truly major operation, as anyone familiar with the island could confirm.

Because I have spent about 18 months in Hirta and visited all the outlying islands in the course of the Soay sheep study, I could hardly let this amount of special pleading and half-truth go unchallenged.

D. C. Gwynne  
The West of Scotland Agricultural  
College  
Auchincruive  
Nr Ayr



## If you could run GRIMBLEDON DOWN...



Tell us what your plans  
would be and win a prize

You have been appointed director of Grimbledon Down—or any other government research establishment. A team of top-flight scientists, of all disciplines, is at your command. How would you go about your job? What projects, not previously tackled by concerted scientific research, would you give to your team of experts? What are the problems, formerly neglected, which you would like to see solved by your research team?

**This is the theme of an essay competition sponsored by New Scientist, which is open to those aged 13 to 18 on 1 September, 1975.**

**Entries, of up to 2000 words, should aim to explore the subject imaginatively rather than by detailed technical argument. There are no entry forms. Simply type or write your essay, in English, using only one side of the paper and double line spacing. On the top left hand corner of the first page give your full name and address and date of birth. Make sure that your name is on every sheet.**

The winning essay (the judges will take entrants' ages into account) will be published in New Scientist. The winner will also receive £20 and there

are two 2nd prizes of £10. All prize winners and 10 runners-up will be given a free subscription for one year to New Scientist. The competition closes on Friday, 28 November 1975, and the results will be announced in New Scientist on 4 March 1976. The panel of judges will include Dr Bernard Dixon (Editor of New Scientist).

### Post your entry to:

Jim Watts,  
New Scientist,  
128 Long Acre,  
LONDON WC2E 9QH.

# CLASSIFIED ADVERTISEMENTS

LINE RATE 85p per line CM RATE £4.05 per single column cm

Advertisements received first post Monday will be published the following Thursday  
If proofs are required; copy should be sent 8 days prior to publication date

Advertisements should be addressed to  
Classified Advertisement Manager  
NEW SCIENTIST  
128 Long Acre, London, WC2E 9QH.  
Tel: 01-836 2468 T-lex: 27253

## APPOINTMENTS AND SITUATIONS VACANT



### LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

#### LECTURESHIP IN MATERIALS ENGINEERING

Applications are invited for a LECTURESHIP in the Department of Materials Technology. Areas of work will include development of the undergraduate course in Materials Engineering and postgraduate work in materials technology.

Preference will be given to applicants whose initial qualifications are in engineering and who have specialist experience in fracture mechanics and the properties of materials in relation to engineering design requirements. There will also be considerable scope for the development of postgraduate courses and research and the appointee will be expected to contribute to these activities.

Salary within notional scale £2778-£3650 plus threshold payment of £83.52. Postcard requests for further details and application forms to Assistant Registrar (Establishment) ref. 75/36/W. Loughborough Leicestershire

#### CHAILEY HERITAGE CHILDREN'S HOSPITAL ELECTRONICS/TECHNICIAN

A new post in the Experimental Workshop, Chailey Heritage Children's Hospital, Lewes, Sussex, to assist with research on equipment for physically handicapped children.

Required: experience in electronic circuitry and instrumentation and fundamental knowledge of measurement and data acquisition techniques.

Qualifications: ONC, HNC, HND, or appropriate degrees, plus experience.

Salary: £3558-£4581 p.a. Whitley Council conditions of service. Phone (Newick 2112) or write to Mr. N. D. Ring (Technical Director) for further details. Applications by October 5.

#### UNIVERSITY OF SOUTHAMPTON PROFESSOR OF ELECTRONICS

Applications are invited for appointment to a Chair of Electronics, which became vacant on the appointment of Professor G. D. Sims as Vice-Chancellor of the University of Sheffield.

Further particulars may be obtained from the Academic Registrar, The University of Southampton, SO9 5NH, and applications (11 copies from applicants in the United Kingdom and one from overseas) must be submitted before 31 October, 1975.



Wellcome

## Chemical or Bio-Chemical Engineer for Process Development PIRBRIGHT, SURREY

Working with a team of experienced microbiologists and process engineers, the successful candidate will be involved in process engineering development work related to the industrial scale production of Foot-and-Mouth Disease vaccine, carrying projects through from inception and design to completion. He will also have plant trouble-shooting responsibilities, and give general process engineering assistance to management within the UK and overseas.

Candidates should be graduate chemical or biochemical engineers with relevant industrial experience. Experience of process development work connected with the production of biologicals would be an advantage. An ability to co-ordinate and liaise with other professionals within a multi-disciplinary team is essential.

The post offers wide scope for personal development and the successful candidate will be encouraged to use his own initiative, creative ability and originality to achieve technical innovations.

The Wellcome Foundation is a major, British-owned, £multi-million pharmaceutical company, and the Foot-and-Mouth Disease unit, situated in pleasant rural surroundings near Pirbright, Surrey, serves as the central R&D Laboratory for the company's expanding world-wide operations in FMD Vaccine production. It is within easy reach of Guildford, Camberley and Aldershot and the general conditions include generous assistance with re-location expenses.

Interviews will be held at Pirbright, but applications giving brief details of age, qualifications and relevant experience should first be sent to:

The Personnel Manager,  
The Wellcome Research Laboratories,  
Langley Court,  
Beckenham, Kent BR3 3BS.  
Please quote reference AQ.592.



#### UNIVERSITY OF WARWICK JUNIOR RESEARCH ASSOCIATE IN CHEMISTRY

Applications are invited from recent graduates (preferably chemists) for a post of junior research associate in the Department of Molecular Sciences, tenable for two years in the first instance. The project will involve a study of the co-ordination chemistry of heavy metals by spectroscopic methods, including pulse Fourier-transform n.m.r. Suitably qualified applicants may study for an MSc degree. Salary approximately £1500 p.a. plus threshold, to be reviewed shortly to take account of arbitration awards. Queries regarding this project should be made to Dr. P. Moore, Department of Molecular Sciences, Coventry CV4 7AL (ext. 2236). Applications in writing as soon as possible to the Academic Registrar, University of Warwick, Coventry CV4 7AL, quoting Ref. No. S/22/75.

#### The Zoological Society of London

#### NUFFIELD INSTITUTE OF COMPARATIVE MEDICINE PHARMACOLOGY TECHNICIAN/RESEARCH ASSISTANT

For 3-year joint project with the MRC Clinical Pharmacology Unit at the Radcliffe Infirmary, Oxford, on reactions of cerebral blood vessels in man and non-human primates after haemorrhagic stroke, especially in neurosurgical patients. Experience of biological assay methods preferred. Salary up to £2436 x £120(2)-£2678. Applications to the Establishment Officer, Zoological Society of London, Regent Park, London NW1 4RY.

#### PORTSMOUTH POLYTECHNIC Department of Biological Sciences HORTICULTURAL TECHNICIAN

A technician is required to run glasshouses in which experimental crops will be grown, as part of a research programme concerned with "Recycling of Solid and Liquid Wastes".

The post is subject to a two-year fixed term contract, with a salary of £2528 rising to £2607 per annum.

Applicants should preferably have a horticultural qualification, but experience in the production of salad crops under glass is also desirable.

Closing Date: 10th October, 1975. Application forms and details of the post are available from: The Staff Officer, Portsmouth Polytechnic, Alexandra House, Museum Road, Portsmouth PO1 2QQ.

# SCIENTISTS & ENGINEERS

**We offer you the most stimulating R&D.....with advanced naval weapons systems**

The Admiralty Surface Weapons Establishment needs graduate scientists and engineers for R & D projects of national importance. You will be involved with some of the world's most advanced and sophisticated equipment, vital to national security and in many cases, to British technological success in the export field.

Among the activities you could be engaged on are computerised action information systems and associated display equipment, target indication and guidance systems, radio and inertial navigational equipment, missile control launching systems, electronic counter-measures, infra-red radar systems, telecommunication, and servo control systems.

You will be working in a friendly informal atmosphere, usually in a small team. The main Establishment is at Portsmouth overlooking the Solent, with subsidiary bases at Eastney (Portsmouth), Funtington (near Chichester) and the Admiralty Compass Observatory, Slough. Wherever you are posted, you will not be desk-bound. There are opportunities for testing and evaluating equipment

at sea, and for international travel on liaison assignments.

Most of the new appointments carry Scientific Officer and Higher Scientific Officer status. Some are at Senior Scientific Officer level. Salary will be: £4180-£5775 (SSO), £3250-£4450 (HSO) or £2150-£3525 (SO); Slough appointment carries an additional £260 p.a. Level of appointment and starting salary will depend on age, qualifications and experience.

There are excellent prospects of promotion to management responsibility. A good honours degree in an appropriate subject is essential. Ages: 25-32 for SSO, under 30 for HSO, under 27 for SO. For full details and application form (to be returned by 10 October 1975) write to:—The Director, Admiralty Surface Weapons Establishment, (for the attention of Mrs C S Strong (XMS2) Portsmouth, Gosham, Portsmouth, PO6 4AA, or telephone Gosham 79411 ext. 2081. Please quote ref. SA/4/FH.



**Admiralty Surface Weapons Establishment**

## UNIVERSITY COLLEGE CARDIFF

Department of Mechanical Engineering

### RESEARCH ASSISTANTS IN SOLAR ENERGY UNIT

Applications are invited for the appointment of three Research Assistants in the Solar Energy Unit. The Assistants will be engaged on the design, construction and commissioning of (a) solar heaters and stills, (b) instrumentation for solar energy measurement and recording and (c) the Unit's solar simulator.

Applicants should have a good Honours degree in Mechanical Engineering and preferably some post-graduate experience. The appointments will be for periods of two or three years, beginning from October 1st, with salaries in the range £2370-£2406 p.a. (under review). Applications, giving brief curriculum vitae and names and addresses of two referees, should be sent to The Registrar, University College, PO Box 78, Cardiff CF1 1XL, not later than September 30th, quoting reference 0590.

## OXFORD UNIVERSITY

The Botany Department requires a technician grade 4 (£2247-£2628) to assist in Plant Biochemistry research. He will also be needed to help in the preparation of practical classes for undergraduates. The normal educational standards required is two GCE 'A' levels in biological subjects, one of which should be in Chemistry and the normal minimum length of background experience required is seven years.

Applications should be made in writing by 26 September to the Administrator, Botany Department, South Parks Road, Oxford OX1 3RA, enclosing a curriculum vitae and the names of two referees.

## GROUP DEPARTMENT OF CHEMICAL PATHOLOGY

# SENIOR NON-MEDICAL BIOCHEMIST

(£3126 - £4092 p.a. plus threshold)

The laboratory which is situated in a new building undertakes paediatric tests for the Sheffield Area and has a close association with neighbouring adult hospital laboratories.

Applicants should possess a 1st or 2nd Class Honours Degree and experience of Paediatric Chemical Pathology, or ultra-micro techniques would be an advantage, as the Senior Biochemist would be expected to undertake development work in this field. Study for a post graduate qualification is encouraged.

Visits welcomed by arrangement with the Consultant Chemical Pathologist, Dr. E. Worthy (Tel. 0742-27511—Ext. 318).

Applications for the above post stating age, qualifications, experience and the names and addresses of two referees to the District Personnel Officer, Sheffield Area Health Authority (Teaching), Central District (Teaching), 10 Beech Hill Road, Sheffield, S10 2RZ, by 25th October, 1975. Further details available on request.

**Sheffield AREA HEALTH AUTHORITY (T.)**  
**central district**

## UNIVERSITY OF SURREY Department of Electronic and Electrical Engineering LECTURESHP

A vacancy for a LECTURER, with recent and up-to-date industrial experience, to assist in teaching the Honours course in electrical and electronic engineering.

The successful candidate will have knowledge and experience in electronic circuit design, or of one of the areas of telecommunications. Salary in the range: £2118-£4696 (under review) with superannuation under USS conditions.

Further particulars may be obtained from the Academic Registrar (LFG), University of Surrey, Guildford, Surrey GU2 5XH, or Tel: Guildford 71281, Ext. 452, to whom applications, in the form of a curriculum vitae, including the names and addresses of two referees, should be sent by: 22 October, 1975.

## HOUGHTON POULTRY RESEARCH STATION SCIENTIFIC OFFICER

with a pass degree HNC or equivalent qualifications required for Physiology and Biochemistry Department to take charge of electrophoretic techniques and assist with the running of a new radioisotope unit.

The appointment will be in the Scientific Officer grade within the scale of £2149 to £3527, according to qualifications and experience.

Non-contributory pension scheme. Further particulars and application forms from the Secretary, Houghton Poultry Research Station, Houghton, Huntingdon, Cambs PE17 2DA.

Closing date for applications 26 September, 1975.

## THE POLYTECHNIC OF NORTH LONDON

### Department of Physics

Applicants are invited for the post of

### RESEARCH ASSISTANT

in the field of Cosmic Ray and Environmental Radiation Physics. The successful applicant will work with a large anticoincidence counter arrangement in the Holborn Underground Laboratory, London. The apparatus has recently been commissioned and the Research Assistant appointed will be responsible for its day to day running, the analysis of the data obtained and the initiation of further experiments.

It is required that applicants should have a good honours degree in Physics; experience of electronics and computer programming would be particularly advantageous. A suitable applicant may be registered for a higher degree.

The salary scale will be £1932 x 62 £2004 plus £351 London Allowance which includes payment for six hours' teaching or comparable duties per week.

The Research Assistant will be appointed for one year in the first instance and subject to annual review, the appointment may be extended to two years or, in exceptional circumstances, three years.

Applications, giving brief details of qualifications and experience, should be sent as soon as possible to the Head of the Physics Department, The Polytechnic of North London, Holloway N7 8DB.

## LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

### LASER APPLICATION RESEARCH

Following expansion of an important research programme applications are invited for posts as RESEARCH ASSOCIATES in the field of laser applications. The posts are sponsored by SRC and government bodies. Candidates should preferably have good degrees in engineering subjects, physics or mathematics.

The posts are renewable annually for periods of up to three years at present within a notional salary scale £2370-£3594 plus a threshold payment. Further details and application forms from Professor John Butters, Department of Mechanical Engineering (EN5).

Loughborough

Leicestershire

### BIOCHEMISTRY TECHNICIAN

or

### TRAINEE TECHNICIAN

research work involving enzyme studies associated with subcellular structures.

Salary scales: Technician Grade 3 £2425 to £2753 pa; Trainee £1490 to £1892 pa; (inclusive of London Allowance).

Applications to Assistant Secretary (Personnel) The Royal Veterinary College, Royal College Street, London NW1 0TU.

### A TECHNICIAN

required to work with research into immunological aspect and immunotherapy in relation to skin tumours. Salary scales: Technician, experience and qualifications. Apply Skin Department, Royal Marsden Hospital, London SW3 6JJ.



## Crown Agents

### THE GAMBIA AGRONOMIST

The appointed officer will be responsible for approved research programmes on field crops, and possibly for an Experimental Farm, and to oversee trials on vegetables and the production of nucleus and foundation seeds of upland crops. He will also assist in the production of technical bulletins and in training technicians to lay down and look after district trials.

Candidates must have an honours degree in Agricultural Science, with a higher degree (or at least three years experience) in the planning, execution, analysis and interpretation of field experiments.

Length of tour will be two tours of 12 to 24 months each. Salary in the scale £2680 to £3150 pa, which includes an allowance, normally tax-free, of £1480 to £3204 pa.

Benefits include 25% terminal gratuity on basic salary, paid passages, education allowances, children's holiday visit passages, generous paid leave, and government accommodation at reasonable rental. An appointment grant of £300 and a car loan of £900 may also be payable.

The post described is partly financed by Britain's programme of aid to the developing countries administered by the Ministry of Overseas Development.

For further particulars you should apply, giving brief details of experience to CROWN AGENTS, M Division, 4 Millbank, London SW1P 3JD, quoting reference MD/611/NR.

## SCIENTISTS! TECHNICIANS!

We have current requirements for:  
**ALL GRADES OF TECHNICIANS & SCIENTISTS**

1. To work in (Research & Routine):  
HAEMATOLOGY, HISTOLOGY, BIOCHEMISTRY, MICROBIOLOGY, and particularly VIROLOGY
2. To act as  
TECHNICAL ADVISORS FOR THE PROMOTION OF DIAGNOSTICS & SCIENTIFIC INSTRUMENTS

Salaries: £2000-£5500

For further details of these and other opportunities in and out of the laboratory, contact:

**Scientific Staff Consultants**

50 LINCOLNS INN FIELDS, LONDON, WC1 0-831 6471

Our service is free to applicants

### THE ROYAL VETERINARY COLLEGE

(University of London)

### ANAESTHETIC TECHNICIAN

required for Department of Surgery at the college's field station nr. Hatfield, Herts, to assist lecturer in anaesthesia with studies in animal anaesthesia. Some experience in the use of medical monitoring equipment would be an advantage.

Salary scale: £2120 to £2447 p.a. (inclusive of London Allowance)

Applications to Assistant Secretary (Personnel) The Royal Veterinary College, Royal College Street, London NW1 0TU.

### TECHNICIAN (GRADE 3)

required for a  
**RESEARCH GROUP**  
in the  
**BIOCHEMISTRY**

Department. The group is investigating the control of protein biosynthesis in mammalian cells. Experience in microbiological techniques and the use of Ultracentrifuges an advantage. Four weeks annual holiday. Contributory Pension Scheme. Salary on scale £2423 pa rising to £2753 pa (exclusive of London weighting). Apply in writing with full details to: Head Clerk, (Ref NS 161407), King's College London, Strand, WC2R 2LS.

### MEDICAL RESEARCH COUNCIL

### Laboratory Animals Centre SENIOR ANIMAL TECHNICIAN

Applications are invited for an interesting position at the Laboratory Animals Centre to assist with the running of the animal houses. Knowledge of animal husbandry and experimental animal techniques is required; experience with small primates is desirable. Applicants must be Fellows of the Institute of Animal Technicians, be thoroughly experienced and staff at all levels is a fundamental aspect of the post. Salary, according to age and experience, in the range £3455-£4722, plus £312 London Weighting.

After satisfactory completion of a probationary period, the successful candidate will become eligible for consideration for the tenancy of a modern, centrally heated cottage on site.

Apply to the Senior Chief Technician, Medical Research Council, Laboratory Animals Centre, Woodmansterne Road, Carshalton, Surrey, SM5 4EF.

### UNIVERSITY OF SURREY GRADE 5 TECHNICIAN Structural Studies Unit TRANSMISSION ELECTRON MICROSCOPIST

Applications are invited for appointment to the above post. Applicants should possess a technical diploma and have at least 5 years experience in transmission electron microscopy.

The appointee will be required to take charge of the maintenance and operation of the EM6G and JEM-100B microscopes together with instructing novice users in operating and specimen preparation techniques.

Acquaintance with either, or both, biological and metallurgical specimen preparation techniques, together with photographic procedures would be an advantage. Although a technical qualification is preferred, a candidate with relevant experience would be considered. Salary will be determined according to qualification and experience within the range £2439-£2895.

Application forms may be obtained from the Staff Officer, University of Surrey, Guildford, GU2 5XH, or tel: Guildford 71281 ext 452.

### SHEFFIELD POLYTECHNIC

DEPARTMENT OF HOTEL & INSTITUTIONAL MANAGEMENT

### LECTURER II IN APPLIED PSYCHOLOGY

This vacancy, which is in an expanding and innovative Department, involves the application of Psychology to work and environmental design with particular reference to the catering industry. Scope for new industry-orientated approach. Teaching at degree and HND levels. Research encouraged.

Salary Scale: £3779-£5493.

Application forms and further details obtainable from the Personnel Officer, Sheffield Polytechnic, Malford House, Fitzalan Square, Sheffield, S1 2BB, to whom completed forms should be returned within fourteen days.



## Air Pollution Control

# Chemists/ Chemical Engineers

(up to £7050)

in Basingstoke, Bristol,  
Cambridge, Leeds, Sheffield,  
Stafford & possibly elsewhere

## Vacancies

affording considerable freedom of action and scope for individual initiative within the Alkali Inspectorate's responsibility for the statutory control of air pollution from certain industrial processes. The work will involve ensuring that plants are properly operated and advising on general plant design, ancillary equipment for pumping, heat transfer etc. An important part of the work is to establish and maintain good relations with industrial management, local authorities and the public.

Candidates must have an honours degree (or equivalent) in chemistry or chemical engineering, or have achieved corporate membership of the Institution of Chemical Engineers, or be Associates or Fellows of the Royal Institute of Chemistry (those awaiting election also considered). Corporate membership of the Institute of Fuel would be an advantage. At least five years' experience in, and wide knowledge of, the process industries is essential. As travelling is involved, ability to drive a car is essential.

Starting salary between £5485 and £7050, depending on qualifications and experience. Promotion prospects and non-contributory pension scheme.

For further details and an application form (to be returned by 31 October 1975) write to Civil Service Commission, Alencon Link, Basingstoke, Hants. RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours) or London 01-839 1992 (24 hour answering service). Please quote T/9098.

## Health and Safety Executive

### UNIVERSITY OF OXFORD Department of Experimental Psychology

The University proposes to appoint a lecturer in Psychology in one or more of the following fields: Animal Behaviour, Animal Learning, Individual Differences, and Social Psychology. This post may be associated with a Fellowship at Wadham College (open to men and women). Salary according to age on the scale £2778-£6462 per annum (under review). The lecturer will be required to pay contributions to a superannuation scheme as prescribed by the Statutes and Decrees of the University. Further details may be obtained from the Professor of Psychology, Department of Experimental Psychology, South Parks Road, Oxford, OX1 3UD, to whom applications (nine typed copies, or one from overseas applicants) should be sent by 31 October, 1975.

### WADHAM COLLEGE OFFICIAL FELLOWSHIP IN PSYCHOLOGY

The College proposes to elect an Official Fellow in Psychology. Both men and women are eligible. The post is to be held in conjunction with the University Lectureship in the Department of Experimental Psychology advertised above.

Applications giving personal details and a statement of academic record should be sent, not later than 31 October, 1975 to the Warden, from whom further particulars, including stipend and teaching duties, may be obtained.

### COMMONWEALTH AGRICULTURAL BUREAUX

## Vacancy for

## SCIENTIFIC INFORMATION OFFICER

at the  
COMMONWEALTH BUREAU OF DAIRY SCIENCE  
AND TECHNOLOGY  
Shinfield, Reading, RG2 9AT

## Duties

Scanning, abstracting and editing technical papers.

## Qualifications

Applicants should be graduates in a relevant subject such as food science, microbiology, biochemistry or agriculture. The ability to write clear and concise English is essential. Equivalent experience may be accepted in place of a degree. Reading ability in one or more foreign languages (preferably German) is desirable. Previous experience of abstracting, editing or indexing would be an advantage.

## Salary

In scale £2149-£3814 plus a compensatory allowance (taxable but not superannuable) of 4½% to offset superannuation contribution (FSSU). Starting point according to qualifications, age and experience, but in the lower sector of the scale. Promotion to higher scales on merit.

Application forms and full particulars from the Secretary, Commonwealth Agricultural Bureaux, Farnham House, Farnham Royal, Slough SL2 3BN.

Closing date for applications: 10 October 1975.

# Registration Officer

Expansion within the Company's Registration Unit has created a vacancy for a Registration Officer.

The person appointed will report directly to the Head of Regulatory Affairs, and will be responsible for dealing with Health Authorities and Agents in Europe, the Middle East, Central and South Africa, Australia and New Zealand.

Applications are invited from candidates with a minimum of 3 years experience as a Registration Officer or Information Officer. A degree in Pharmacology or a biological science is an essential qualification. An ability to communicate accurately in order to advise technical and commercial departments of regulatory requirements is also necessary.

The Company is located at Eastbourne, Sussex, and will shortly be moving to new offices centrally situated in the town. Terms and conditions of employment are excellent, including a contributory Pension and free Life Assurance Scheme.

Applications in writing, giving full personal details, to: The Personnel Manager, Armour Pharmaceutical Company Limited, Hampden Park, Eastbourne, E. Sussex BN22 9AG. Tel: Eastbourne (0323) 34721.



Armour Pharmaceutical Company

### UNIVERSITY OF ABERDEEN LECTURER OR RESEARCH OFFICER IN MEDICAL PHYSICS

Experienced hospital physicist required to join group providing Nuclear Medicine services and a wide range of research. Appointee expected to take special interest in Gamma Camera work initially. He will also join in MSc (Medical Physics) and other teaching courses as appropriate. Salary on scale Lecturer £2778 to £6050 (plus cost of living adjustment to be agreed), Research Officer either £2778 to £5022 or £2370 to £3594, with initial placing according to qualifications and experience.

Further particulars from The Secretary, The University, Aberdeen, with whom applications (two copies) should be lodged by 25 September, 1975.

### ST. GEORGE'S HOSPITAL MEDICAL SCHOOL JUNIOR TECHNICIAN OR TECHNICIAN

For Surgical Unit. Duties include work on an interesting research project on Crohn's disease. Experience in tissue culture required and knowledge of Electron Microscopy an advantage. Whitley Council conditions. Apply to Establishment Officer, St. George's Hospital Medical School, Blackshaw Road, London SW17 0QT.



## UNIVERSITY OF NAIROBI KENYA

Applications are invited for the following posts:—  
**SENIOR LECTURER IN THE  
DEPARTMENT OF CROP  
SCIENCE**

Applicants should have a PhD in Agronomy, Horticulture or Crop Physiology and several years experience in teaching at university level and research work. Preference will be given to applicants who hold a first degree in Agriculture or Horticulture. The appointee will teach graduate and postgraduate courses in Crop Science and in research.

## LECTURER IN THE DEPARTMENT OF AGRICULTURAL MECHANISATION AND FARM PLANNING

Applicants should have a good BSc degree in Agricultural Engineering, Postgraduate academic standing is also required. Specialisation in agricultural processing or farm power and machinery is preferred. The appointee will teach agricultural engineering—and agricultural students both at undergraduate and graduate levels.

**Salary Scale:**—SENIOR LECTURER—K2722-£3600 p.a. LECTURER—K1800-£3096 p.a. (K11—£1-33 sterling). The British Government may supplement salaries in range £2124-£2880 p.a. (sterling) for single appointees (normally free of all tax) and provide children's education allowances and holiday visit passages. FSSU. Family passages; various allowances. Detailed applications (2 copies) including a curriculum vitae and naming 3 referees should be sent by airmail not later than 14 October, 1975 to Registrar, University of Nairobi, P.O. Box 30197, Nairobi, Kenya. Applicants resident in UK should also send one copy to the Inter-University Council, 90/91 Tottenham Court Road, London W1P 0DT. Further particulars are available from either address.

## THE POLYTECHNIC OF NORTH LONDON

### Department of Food Sciences

Applications are invited from suitably qualified candidates for the appointment of a  
**LABORATORY TECHNICIAN  
(Grade 6)**

in the Department of Food Sciences to be responsible for the general running of the laboratories in the department, with particular emphasis on physiology. The post is one of variety and interest and involves co-ordination and work in microbiology, food science, domestic equipment and textiles, as well as the main subjects of physiology.

Applicants should have at least 9 years relevant experience together with advanced formal qualifications.

**Salary Scale:** £2844 rising by annual increments to £3450 per annum plus £411 London Weighting.

Applications, together with the names of two referees should be made as soon as possible to the Head of the Department of Food Sciences, The Polytechnic of North London, Holloway Road, N7 8DB.

## BUREAU TECH (SCIENTIFIC STAFF AGENCY)

Top jobs for ONC/HNC/HND/AIMLT/BSc. (Chem; Phys; Biol; Med. Lab. subjects)

We find you the job free of charge  
Tel: 01-959 3517.



Wellcome

# Virologist

## Research Section Leader PIRBRIGHT, SURREY

The Wellcome Foot-and-Mouth Disease Vaccine Laboratory at Pirbright, Surrey, serves as the world centre for research and development work on foot-and-mouth disease vaccines within the Wellcome Foundation Group of Companies.

An opportunity has arisen for a Virologist to join this active research team. The successful candidate will lead a section of some twelve people, whose field of interest covers all aspects relating to the identification and selection of good immunogenic vaccine seed viruses of appropriate serological specificity.

The work of this section is integrated closely with the work of the Formulation, Process Development, Immunology and Production sections. Excellent opportunities are available for original work at a fundamental level and publication is encouraged.

The successful candidate will be between 28 and 40 years of age and will preferably have a post-graduate degree obtained in the field of virology.

The Wellcome FMD Vaccine Laboratory is situated at Pirbright, Surrey which is about 4 miles from Guildford. General conditions of employment are excellent and include assistance with re-location expenses, where appropriate.

Applications, giving brief details of background and experience should be sent, quoting

ref. AQ.602, to: The Personnel Manager,

The Wellcome Research Laboratories,

Langley Court, Beckenham, Kent BR3 3BS



## Central and Southern Health District

(TEACHING)  
LIVERPOOL A.H.A. (T)

## ELECTRONICS ENGINEER/ PHYSICIST

To undertake development work in a wide range of medical activities. Applicants should have at least five years experience in electronics since graduating. Experience in medical work is desirable but not essential.

The post is within the joint hospital/University Bio-Engineering and Medical Physics Unit.

**Salary scale** £4437—£5697 per annum. (Senior Medical Physicist Grade)

Application form and job description available from the District Personnel Officer, 80 Rodney Street, Liverpool L1 9AP or telephone Dr M. C. Brown 051 709 5533 Ext. 36

Closing date: 2nd October 1975

(14735)

NS 15363

## BREWING INDUSTRY RESEARCH FOUNDATION

Nutfield, Surrey

### EXPERIMENTAL OFFICERS

Vacancies occur for Experimental Officers in:

a) The Analytical Section—to develop and evaluate new analytical procedures and to apply specialist methods of analysis. Experience in GLC techniques or analysis of natural materials would be an advantage.

b) The Chemistry Section—to work on raw materials used in the brewing process. The successful applicant will assist with the isolation and characterisation of compounds which are of importance with regard to beer flavour.

First degree graduates preferably with some post graduate research experience are invited to apply.

Appointments will be made within the salary range of £2637-£5443.

Superannuation will be under the Institute of Brewing Superannuation Scheme with life insurances as a scheme benefit.

Applications including a curriculum vitae, should be sent as soon as possible to the Administrative Manager, Breweries Research Foundation, Nutfield, Redhill, Surrey RH1 4HY.

## THE UNIVERSITY OF BATH

### School of Pharmacy & Pharmacology

#### TECHNICIAN

A technician is required in Pharmaceutical Chemistry within the School. The post involves assistance with the operation of teaching and research laboratories. A good background in Chemistry is necessary and a knowledge of analytical and/or preparative organic chemistry is desirable.

Applicants should possess at least an O.N.C. or equivalent in Chemistry, preferably H.N.C., with relevant experience.

Salary in the range £2013-£2343 per annum (under review).

Application forms from the Personnel Officer, The University of Bath, Bath BA2 7AY, quoting reference 75/137, should be returned by 26th September.

## WELSH NATIONAL SCHOOL OF MEDICINE

(University of Wales)

### Dental School

#### RESEARCH TECHNICIAN IN DENTURE BASE POLYMERS

Applicants are invited from technicians with ONC or other suitable qualifications to undertake a 3-year research project in the Department of Restorative Dentistry into injection moulding of denture base polymers. Salary range up to £2500. Applicants are invited to visit the Department to discuss the project with the Professor.

Application forms available from the Registrar, Welsh National School of Medicine, Heath Park, Cardiff, CF4 4XN to whom they should be returned as soon as possible (quoting reference No. M16/84/77).

## KING'S COLLEGE HOSPITAL MEDICAL SCHOOL

(UNIVERSITY OF LONDON)

Denmark Hill,

London, SE5 8RX

### Department of Surgery

#### JUNIOR TECHNICIAN

for biological research. Experience desirable but not essential. Whitley Council Salary. Day release.

Apply to: Dr A. Bennett.

## Oxford English Dictionary Editorial Assistant (Science)

There is a vacancy for an Editorial Assistant for the *Supplement to the Oxford English Dictionary*, now in preparation at Oxford (Volume I, A-G, was published in 1972). The successful applicant will be concerned chiefly with the preparation of entries for scientific terms, primarily in the physical sciences.

A good (not lower than Second Class) degree in one of the physical sciences is necessary; particular consideration will be given to graduates with a knowledge of chemistry. Experience beyond a first degree is desirable, together with an interest in the history of scientific terminology as a whole. Salary according to experience and qualifications on the scale £2075-£3350 per annum, with participation in the Oxford University Press superannuation scheme.

Further particulars may be obtained from the Personnel Department (CRB), Oxford University Press, Walton Street, Oxford, OX2 6DP, to whom applications should be made in writing, with full curriculum vitae and the names and addresses of two referees, before 3 October.

## Drug Registration

A vacancy exists in the Co-ordination and Regulatory Affairs Department of Beecham Pharmaceuticals, Research Division, the successful applicant to be responsible to the Head of Regulatory Affairs. The work concerns the editing and collation of information, involving chemical, pharmaceutical and experimental data, on all medical and veterinary products under development for registration with the U.K. and overseas Health Authorities.

This position will be particularly suitable to a graduate with some experience of registration. Applications will be considered from Honours Graduates in Chemistry or the Biological Sciences where particular interest in Pharmacology or Pharmacy would be advantageous.

Beecham Pharmaceuticals, Research Division is part of the Beecham Group and is situated in a pleasant area of Surrey within easy reach of London. There are generous fringe benefits including sick pay, non-contributory pension fund and bonus scheme.

Please reply to the Site Personnel Officer,  
Beecham Pharmaceuticals, Research Division,  
Brockham Park, Betchworth, Surrey,  
or telephone Betchworth 3202  
for an application form.



1972

### LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE

(University of London)

Keppel Street,  
London WC1E 7HT  
A TECHNICIAN

is required for a period of three years in the Department of Medical Protozoology, to join a small team studying the immune response to *Trichomonas vaginalis*.

Applicants should possess a degree or HNC; experience with immunological techniques is desirable but not essential. Initial salary will be not less than £2067 p.a. (under review), plus £312 London Weighting, with the possibility of early promotion.

Applications with full curriculum vitae and the names of two referees should be sent to the Secretary (A1).

### MEDICAL RESEARCH COUNCIL

PHOTOGRAPHIC  
TECHNICIAN

required for Biological Research Laboratory.

The post is concerned with printing of work from X-ray diffraction, gel electrophoresis, electron and light microscopy techniques, etc.

At least 4 years' experience of similar work required and preferred age around 30.

Qualifications to HNC level or equivalent.

Salary at the appropriate point on the scale £2511-£3738 plus London Allowance of £312.

Apply to the Administrative Officer, MRC Cell Biophysics Unit, 26-29 Drury Lane, London, WC2.

Ministry of Defence  
JARK (UK) RAF Brampton

## Systems Analyst

to be responsible for the detailed systems analysis of new requirements and applications for a variety of data processing tasks. Duties involve providing outline specifications, presenting professional advice on the feasibility and merits of alternative approaches and developing the existing CIL 1900 system.

Candidates (aged normally under 32) must have a 1st or 2nd Class honours degree or equivalent in an appropriate scientific subject, together with at least 4 years' postgraduate experience covering both hardware and software systems.

Salary as Senior Scientific Officer, between £4180 and £5775 according to qualifications and experience.

Application forms (for return by 10 October 1975) from Procurement Executive, Ministry of Defence, SPM 1b3, Room 210, Savoy Hill House, Savoy Hill, Strand, London WC2R 0BX. Please quote SA/4/FMA.

### UNIVERSITY OF ABERDEEN

Department of Medical  
Physics

PHYSICIST/BIOENGINEER

A vacancy exists for an experienced Physicist/Bioengineer with at least an upper second class degree to join a group which provides Ultrasonic Services in a major teaching hospital and Medical School.

The person appointed will be expected to contribute substantially not only to the wide programme of research, but also to the clinical service work of the Department. Experience in Ultrasonics, Applied to Medicine, Bioacoustics, Bioengineering or other relevant fields would be an advantage.

Salary on Research grade Range 1A-£2778-£5022 per annum, with superannuation benefits.

Further particulars from The Secretary, The University, Aberdeen, to whom applications (2 copies) should be lodged by 15th October, 1975.

### LONDON BOROUGH OF BARNET

Education Department  
Barnet College of Further  
Education

TECHNICIAN

required for Engineering Science Laboratories. Experience with combustion engines, steam plant desirable and duties would include material testing. Salary scale (over 21 years of age) £2145-£2454 per annum inclusive. Details and application form from The Principal, Barnet College of Further Education, Wood Street, Barnet. Tel. 01-449 9191. Ref. 198.

Department of Industry  
Warren Spring Laboratory, Stevenage

## ENGINEER/ CHEMICAL ENGINEER

to work on waste  
recycling methods

An Engineer/Chemical Engineer is required to join a multi-disciplinary team working on the recovery of re-usable materials from a variety of solid wastes, including domestic refuse. The successful candidate will supervise a small group of qualified technologists concerned with the physical processing of low value, bulk materials, eg metallic/industrial minerals or chemicals.

Candidates (aged under 32) must have a good honours degree or equivalent in Engineering or Chemical Engineering, plus appropriate experience.

Appointment will be as Senior Scientific Officer (£4180—£5775) or Higher Scientific Officer (£3250—£4450) according to age and experience.

For further details an application form (to be returned by 14 October, 1975) write to Department of Industry, Warren Spring Laboratory, PO Box 30, Gunners Wood Road, Stevenage, Herts. quoting ref. SA/35/MF.



### HARINGEY EDUCATION SERVICE LABORATORY TECHNICIAN

Full Time, required at St. David's C.E. Boys' School, Rectory Gardens, N8 7QN, to work 35 hours per week.

Salary rising to £3114 per annum inclusive. Commencing salary according to qualifications and experience.

Minimum qualifications:—

Ordinary National Certificate or Ordinary National Diploma City and Guilds Laboratory Technicians Certificate; 4 G.C.E. passes with 2 at 'A' levels in appropriate subjects. Membership of Institute of Science Technology OR an equivalent suitable qualification OR 5 years' suitable experience.

Application forms obtainable from Chief Education Officer, Education Offices, Somerset Road, N17, returnable by 3 October, 1975.

### UNIVERSITY OF NOTTINGHAM

Department of Zoology

Applications are invited from recent biology graduates for the post of research assistant in the invertebrate tissue culture laboratory of the above Department.

The work will be supported by an Agricultural Research Council grant for three years, at a salary of £2059 rising to £2348 (including threshold).

Applications, together with the names of two referees and a curriculum vitae, should be sent to The Secretary, Department of Zoology, The University, Nottingham, NG7 2RD.

## Central and Southern Health District (TEACHING) LIVERPOOL A.H.A.(T)

### SENIOR PHYSICIST

AT THE MERSEY REGIONAL RADIATION  
PROTECTION SERVICE CENTRE

To assist the Regional Radiological Protection Adviser in the supervision of film badge and monitoring services, the performance of radiation safety surveys, and the provision of diagnostic X-Ray physics services in more than 200 hospitals and other departments.

Applicants must have appropriate hospital experience, preferably in radiation protection and/or diagnostic X-Ray Physics.

Salary scale £4437 to £5697 per annum.

Application form and job description obtainable from the District Personnel Officer, 80 Rodney Street, Liverpool L1 9AP Closing date 29th October 1975. (14734)

NS 15362

### WESTMINSTER MEDICAL SCHOOL

Predictorial immunologist to undertake cell culture and phagocyte studies in relation to immunodeficiency states (especially candidiasis), and their treatments.

Salary on Whitley 'A' scales, up to £3380 p.a.  
Applications (two referees) to Professor J. R. Hobbs, Department of Chemical Pathology, 17 Page Street, London SW1P 2AR by 29/9/75.

### TECHNICIAN

required in Dept. of Experimental Pathology to work on immunosuppression and cancer treatment in laboratory animals and man. Previous laboratory experience required. Commencing salary within scale £2511/£3198 p.a. plus £312 p.a. London Allowance. Further details from Dr. M. C. Berenbaum. Tel: 724-1252 Ext. 315. Apply, The Secretary, St. Mary's Hospital Medical School, Paddington W2 1PG.

## ELSEVIER SCIENTIFIC PUBLISHING COMPANY

(international publishers of scientific journals and books) has an opening in Amsterdam for a full-time

## EDITORIAL ASSISTANT

for work on scientific journals and books in the technological sector.

Applications are invited from graduates in a technological subject (e.g. materials science, metallurgy, mechanical engineering, chemical engineering, electrical engineering) or possibly chemistry or physics.

The work is responsible and varied and involves preparation of manuscripts for printing, correction of proofs, language correction of contributions written by non-English-speaking authors, and supervision of freelance workers.

Essential requirements are English as mother tongue, an appreciation of good English style, and a meticulous eye for detail. A reading knowledge of French and German would be advantageous.

Handwritten applications giving details of education and experience and an indication of salary expected should be addressed to the Personnel Department, Associated Scientific Publishers, P.O. Box 2400, Amsterdam, The Netherlands.

### UNIVERSITY OF LEICESTER Department of Anatomy

#### TECHNICIAN

required to take charge of technical services in the dissecting room of the new Medical School. This is a responsible position which will quickly expand in scope as the projected annual increase in the size of the Medical School takes place. Appointment will be made initially on the scale £2247 to £2620 or £2439 to £2895 p.a. (scales under review) according to age and experience. Applications by 10 October to the Professor of Anatomy, Department of Anatomy, University of Leicester, Leicester, LE1 7RH.

If required, further particulars of the post may be obtained by writing to the Department of Anatomy.

### TESSIDE POLYTECHNIC

## LECTURER II

Applications are invited for the above post from APPLIED MICROBIOLOGISTS with experience in Fermentation Technology.

Salary: Lecturer II/Senior Lecturer £3279x£219—£5031 (efficiency bar) x £231—£3955 (work bar) x £231—£4417.

Application forms, returnable in two weeks, are available from the Staffing Section, Tesside Polytechnic, Middletonbrough, Cleveland County TS1 3BA.

## Thames Water Authority

Metropolitan Public Health Division

### Scientific Officer

Beddington Sewage Treatment Works,  
Croydon, Surrey.

Salary: £4280—£4571.

Required to carry out routine analysis and help with supervision of junior staff. Applicants should be able to undertake non-routine analysis with the minimum of supervision.

HNC or degree in Chemistry with experience of sewage analysis is required.

For an application form please write to the Personnel Branch, Thames Water Authority, Metropolitan Public Health Division, Room 311, 10 Great George Street, London SW1P 3AB. (telephone 633 4141). Please quote reference MPH/211/358.

Closing date 3rd October.

## PROGRAMMERS

Due to expansion the following vacancies have arisen for 1900 series Programmers:

### SENIOR PROGRAMMERS

Minimum three years' experience in Plan/Cobol

### JUNIOR PROGRAMMERS

Minimum one year's experience in Plan or Cobol

The above positions offer excellent opportunities and salaries for suitably qualified applicants

Assistance with removal expenses for suitable applicants

For application form please apply to:

### Personnel Officer

**STYLO BARRATT SHOES LTD.,**  
Kingsthorpe Road, Northampton, NN2 6EL  
Tel. (0604) 715500

## Quality Control Chemist

Skelmersdale, Lancs

An experienced chemist required to deal with chemical aspects of metal container coatings and ensure production process hygiene requirements are met.

He should be capable of advising and acting on a variety of chemical technical service work both internally and with customers.

Attractive salary, conditions of employment and assistance with removals.

Please apply to: **Mr G. Rowe,**  
Nacanco Ltd.,  
Salhouse Road, Norwich NR7 9AT.  
Tel: (0603) 47313.



**Nacanco Limited**

Cambridgeshire Area Health Authority (Teaching)  
Cambridge Health District (Teaching)

## Scientific Officer

Required for a newly established **CLINICAL IMMUNOLOGY SERVICE** at the District Teaching Hospital. Applicants for this post should be graduates in the Biological Sciences with, in addition to a broad experience of advanced immunodiagnostic techniques, some special expertise in one area such as lymphocyte functions, complement studies or protein separation techniques. Extensive laboratory facilities are available for the development and evaluation of new tests applicable to clinical work, under the direction of the Consultant Clinical Immunologist, Dr D L Brown.

Starting salary will be based on Biochemist (£2976—£3933) or Senior Biochemist (£4437—£5697) pay scales depending upon previous experience and qualifications.

Application form and job description from District Personnel Officer, New Addenbrooke's Hospital, Hills Road, Cambridge. Closing date 20th October, 1975.

### AGRICULTURAL RESEARCH COUNCIL

Unit of Nitrogen Fixation  
University of Sussex,  
Brighton BN1 9QJ

**CHEMIST**  
with experience in co-ordination and bio-inorganic chemistry is required for research, in the first instance, into the chemistry of iron-sulphur cluster systems. The post is graded Higher Scientific Officer, salary scale £3524-£4454 per annum. Starting salary depending on qualifications and experience.

Candidates should have a good honours degree with at least 2 years appropriate postgraduate research experience.

Superannuation under a non-contributory scheme, but male employees are required to contribute 1½% for Widows and Children's benefit.

Applications in writing to the Secretary, with curriculum vitae and the names of three referees by 3 October, 1975.

### CHARING CROSS HOSPITAL (FULHAM)

## BIOCHEMIST (Basic Grade)

Graduate in Chemistry or Bio-Chemistry required in Department of Forensic Medicine for toxicological analysis of body fluids. Experience with modern analytical techniques an advantage.

Salary scale £2589-£3702 inclusive. Entry point dependent upon qualifications. Whitley Council Conditions of Employment apply. Applications to **Mr C. Hill, Personnel Department, Charing Cross Hospital (Fulham), Fulham Palace Road, London W6.** Tel: (01) 748 2050 ext. 2992.

### QUEEN MARY COLLEGE University of London NUCLEAR REACTOR PHYSICIST

Applications are invited for this appointment at the Nuclear Physics Laboratory housing a 100 kW teaching and research reactor. Duties will include assisting in the day-to-day operation of the reactor, developing the activation analysis and noise analysis facilities and assisting in the supervision of MSc and undergraduate project and course experiments. Opportunity for personal research. Experience in nuclear instrumentation, neutron activation and noise analysis techniques an advantage.

Salary scale (under review) £2746-£4018 p.a. (including London Allowance and Threshold, expected to be not less than £2612-£3505 p.a. from 1 October). FSSU/USS membership. Application forms and further details available from The Registrar, (NS) Queen Mary College, Mile End Road, London E1 4NS, to be returned by 17 October.

## SOUTH WEST DISTRICT BASIC GRADE BIOCHEMISTS

Leicestershire Area Pathology Service

Due to developments in relation to the newly established Medical School at the University of Leicester, two new posts for Basic Grade Biochemists (or Probationists) have been established in the above service based at The Leicester Royal Infirmary.

Written applications giving full details of age, qualifications and experience with the names and addresses of two referees, to the Hospital Secretary, The Leicester Royal Infirmary, Infirmary Square, Leicester.

Closing date for receipt of applications—2 October 1975.



## Leicestershire Health Service

LEICESTERSHIRE AREA HEALTH AUTHORITY (TEACHING)

### FELLOWSHIPS, GRANTS AND SCHOLARSHIPS

#### UNIVERSITY OF SOUTHAMPTON S.R.C. RESEARCH FELLOW

required for established team in Applied Electrostatics at the Department of Electrical Engineering. Department to work on a major surface coatings project, jointly supported by S.R.C. and U.K. and overseas companies.

The work calls for a study of charged particle behaviour in surface coating processes involving polymer powders. Extensive research facilities include coating equipment and optical systems, e.g. laser anemometry. A good degree in Physics, Engineering, or Chemistry, together with research experience, would be essential.

The starting salary would depend on age and experience. Superannuation benefits. The appointment is for 2½ or 3 years, renewable annually.

Further information may be obtained by writing to Mr. D. A. S. Copland, The University, Southampton SO9 5NH, quoting reference 414/R/NSC.

#### IMPERIAL COLLEGE Department of Zoology and Applied Entomology RESEARCH FELLOW IN INSECT PHYSIOLOGY

Applications are invited from post-doctoral workers for the above ARC-sponsored post (start-in salary up to £3161 per annum scale under review), tenable at the College Field Station, Silwood Park, Ascot, for three years. The successful applicant will be engaged on the neuro-endocrinological control of aphid polymorphism.

Experience in electron-microscopy desirable.

Applications, with the names of two referees, to Prof. A. D. Lees, FRS, Imperial College Field Station, Silwood Park, Ascot, Berkshire, by 30 September.

#### UNIVERSITY COLLEGE OF NORTH WALES, BANGOR RESEARCH FELLOWSHIP

A research fellowship is offered in the School of Physical and Molecular Sciences for work on the development of metallic Ferro-magnetic Liquids. These many applications but the immediate problem is to produce a fluid which may be used for energy conversion. The problem involves both theoretical and experimental work and a knowledge of magnetism and magnetic measurements would be an advantage. A salary of between £2500-£3000 is payable depending on qualifications (University Superannuation Scheme). For a successful applicant an immediate appointment is possible.

Applications (two copies) by letter, giving full details of age, qualifications and experience to two referees, with the names and addresses of two referees should be sent to the Secretary and Registrar, University College of North Wales, Bangor.

#### UNIVERSITY OF NOTTINGHAM MEDICAL SCHOOL

Department of Biochemistry  
POST-DOCTORAL RESEARCH  
FELLOW

Applications are invited for a research fellowship financed by a grant from the MRC for study of phospholipid metabolism in relation to stimulus-secretion coupling in endoplasmic reticulum. The fellowship is tenable for three years from October 1 1975 or a date to be agreed. Initial salary is in the range £2800 to £3160, with membership of USS.

Applications with curriculum vitae and the names of two referees should be sent as soon as possible to Professor J. N. Hawthorne, Department of Biochemistry, University Hospital and Medical School, Nottingham NG7 2UH, from whom further details may be obtained (telephone 0602-700111, ext. 3139).

#### UNIVERSITY OF YORK Department of Biology POSTDOCTORAL RESEARCH FELLOWSHIP

Applications are invited for a postdoctoral Research Fellowship for a period of two years from 1 October 1975 or as soon as possible thereafter) from those with previous research interests in ecological aspects of the plant-soil relationships. The successful applicant will work as a member of a team concerned with various aspects of colliery spoil reclamation and will be particularly concerned with the performance of a range of grass varieties on the substrate.

The research is supported by the Department of the Environment and is directed by Dr M. J. Chadwick.

Salary (under review) within the range £2778-£3594 with USS.

Three copies of applications containing a curriculum vitae and the names of two referees should be sent by 3 October to the Registrar, University of York, Heslington, York YO1 5DD. Please quote reference number/6053.

#### UNIVERSITY OF WARWICK POSTDOCTORAL FELLOW

Applications are invited for a post of postdoctoral fellow in the department of Physics to work with Dr B. W. Holland on the Theory of Angle-Resolved Electron Emission from Solid Surfaces. The appointment will be made for two years in the first instance, on the scale £2778-£3196 p.a. (under review). Candidates should have previous experience in solid state theory and preferential computing. Application form from the Academic Registrar, University of Warwick, Coventry CV4 7AL, quoting Ref. No. 5/F/75. Closing date for receipt of applications is 3 October, 1975.

### STUDENTSIPS

#### THE UNIVERSITY OF SHEFFIELD

Department of Obstetrics and  
Gynaecology

#### A MRC POSTGRADUATE STUDENTSHIP

is available in the above Department for research in Labour Ward data handling and on implications for future fetal monitoring. The minimum qualification required: good second class honours in biology, science or engineering. The Labour Ward includes a comprehensive patient monitoring system based on equipment designed in department. RDB 6/2 computer available, currently used to analyse fetal heart rate data and predict fetal oxygenation to extend this facility to include more data from mother and baby.

Applications to Dr R. J. Parsons, Lecturer in Medical Physics, Jessop Hospital for Women, Sheffield S3 5LE, as soon as possible. Please quote ref: R 280/H.

#### THE MEDICAL COLLEGE OF ST. BARTHOLOMEW'S HOSPITAL

University of London

Applications are invited from good Honours graduates in Chemistry or Biology for a studentship for an SRC "CASE" Studentship, tenable for 3 years (£1180 p.a. plus fees and BSA award in association with the University). The project is Catalysed Lipid Oxidation in Aqueous Emulsions. The project will be carried out in cooperation with Unigate Foods, Ltd. The holder would be expected to register for Ph.D. degree, and to be writing to the Secretary of The Medical College, West Smithfield, London EC1A 7BE.

#### THE POLYTECHNIC, WOLVERHAMPTON Department of Physical Sciences

#### RESEARCH STUDENTSIPS

Applications are invited for research studentships for work on:

- 1) Synthetic Bio-polymer Conjugates
- 2) Organometallic Synthesis and Drug Design;
- 3) Gel Permeation Chromatography;
- 4) Synthetic Non-aqueous Enzyme Systems

Posts (1) and (2) are industrially funded and a minimum qualification required is a Class 2 Division 2 (or exceptionally a 3rd) BSc Honours Degree with Chemistry or Bio-Chemistry as a major subject.

Posts (3) and (4) are SRC CASE awards for which the minimum qualification is a Class 2 Division 1 BSc Honours or MSc Degree.

Grant students living away from home (£1085 p.a. plus tuition fees).

Applications (written or telephone) to Dr R. Epton, Department of Physical Sciences, The Polytechnic, Wolverhampton, WV1 1LJ. Telephone Wolverhampton 97371 (Ext. 51).

#### UNIVERSITY OF YORK

Department of Biology

#### SRC CASE STUDENTSHIP: KINETICS OF FERTILISER PHOSPHATE IN SOILS

Phosphate is likely soon to be the major limiting nutrient for crop production. The project will examine the factors controlling the processes by which fertilizer phosphate in soil is rendered unavailable to crops, and attempt to provide positive techniques for long-term fertilisation programmes to conserve a diminishing resource.

The project will be supervised by Dr R. Fitter (Department of Biology, York) and Dr C. D. Sutton (Fisons, York). Visit to Research Station, Ipswich, Suffolk).

Applicants should have, a first or upper second class honours degree in science, and should contact Dr. Fitter, Supervisor at the Department of Biology, University of York, Leazes Road, York, YO1 5DD, as soon as possible.

#### THE UNIVERSITY OF LEEDS DEPARTMENT OF MEDICINE LEEDS GENERAL INFIRMARY

Research Studentship vacant for 3 years involving as part of a research team studying insulin metabolism in diabetes mellitus. The holder of the biochemical or biological sciences graduate wishing to work for a further degree.

Technical help available. Salary at MRC studentship rate.

Apply to Dr J. K. Wales, Senior Lecturer, Department of Medicine, Mariner Wing, Leeds General Infirmary, Leeds LS1 3EX for further details.

#### UNIVERSITY OF LEICESTER RESEARCH STUDENTSHIP in the Department of Chemistry

Applications are invited for a Research Studentship, tenable from 1 October or as soon as possible thereafter, to the value of £1085 plus fees (BSA award in association with the University) to study the Generation of Carbonium Ions from Alkanes using Fluoride Lewis Acids.

Applications, including the names of two referees and a curriculum vitae, should be sent to Dr J. H. Holloway, Department of Chemistry, The University, Leicester, LE1 7RH.



## UNIVERSITY OF WALES university college of swansea Postgraduate Research

Applications are invited from suitably qualified graduates in any of the physical sciences for two post-graduate (CASE) studentships in the Department of Metallurgy and Materials Technology.

(a) To study the effects of hydrogen on the structural properties of austenitic stainless steels in relation to the use of these materials in hydrogen-containing pressure vessels and chemical engineering plant.

(b) To study the high temperature creep and fracture behaviour of low alloy creep resisting steels in relation to their use in power station pressure vessels in conjunction with the CGB Marchwood Engineering Laboratories.

Application forms may be obtained from the Registrar/Secretary, University College of Swansea, Singleton Park, Swansea SA2 8PP, to whom they should be returned as soon as possible.

## UNIVERSITY OF ABERDEEN Department of Chemistry

Applications are invited for an SRC Studentship tenable from 1 October, 1976, under the supervision of Dr. Bett in collaboration with Dr. R. A. Cox and Dr. R. G. Derwent at AERE Harwell. This studentship is for work on the photolysis of alkyl nitrates and their role in polluted atmospheres. Applications, including the names of two referees should be sent as soon as possible to Dr. L. Bett, Department of Chemistry, University of Aberdeen, Meston Walk, Old Aberdeen, AB9 2UE from whom further information can be obtained.

## UNIVERSITY OF NOTTINGHAM

### Department of Physics

Applications are invited for a Science Research Council Studentship to undertake an investigation of the molecular structure and mobility of water in solutions and gels of proteins using magnetic resonance and viscoelastic techniques.

Applications, with the names of two referees, should be sent to Dr. W. Derbyshire, Department of Physics, University of Nottingham, University Park, Nottingham.

## S.R.C. CASE STUDENTSHIP OXIDE ELECTRODES

Project involves electrochemical and microstructural investigations of oxide electrodes being developed for use in fuel cells, electrolyser, oxygen monitors. Investigation is part of larger programme concerned with development of new materials for electrochemical devices. For further information contact Dr. B. C. H. Steele, Dept. of Metallurgy & Materials Science, Imperial College, London, S.W.7.

## DEPARTMENT OF METALLURGY AND SCIENCE OF MATERIALS

### UNIVERSITY OF OXFORD

#### CASE Studentships

Applications are invited from graduates (or students expecting to graduate this year) with a good Honours Degree or an MSc in Materials Science, Metallurgy, Physics, Chemistry, Engineering, etc, for one of the Science Research Council CASE studentships (Co-operative Award in Science & Engineering) listed below. The student will work for the degree of DPhil and will be based in the Department of Metallurgy and Science of Materials, University of Oxford, although some of the work will be carried out in the collaborating institution.

(1) Studies of the Reactions between Portland Cement and Water, in collaboration with the Cement and Concrete Research Association, Slough.

(2) Segregation Studies in Multi-component Alloys, in collaboration with Alcan International Limited, Banbury.

(3) Measurement of Auger Electron Yields over an Extended Range of Primary Energy, in collaboration with AERE Harwell.

Candidates should apply as soon as possible, giving a brief curriculum vitae and the names of two referees to the Administrator, Department of Metallurgy and Science of Materials, University of Oxford, Parks Road, Oxford OX1 3PH.

## LOTHIAN REGIONAL COUNCIL

### NAPIER COLLEGE OF COMMERCE AND TECHNOLOGY

A vacancy exists for

#### SRC CASE RESEARCH STUDENTSHIP IN THE DEPARTMENT OF CHEMISTRY

Applications are invited from persons suitable qualified under SRC regulations for a CASE Research Studentship leading to the degree of PhD.

The project would entail investigations into the mechanisms of plumbosolvency in drinking water and close co-operation with the Water Supply Services of the Lothian Region.

Applicants who should have or expect to obtain a good honours degree or its equivalent in chemistry should apply to Dr G. H. W. Milburn, Head of Department of Chemistry, Napier College of Commerce and Technology, Colinton Road, Edinburgh EH10 5DT, before 30 September, 1975.

## LECTURES, MEETINGS AND COURSES

## 2 Science 'A' Levels?

If you have one from each of the following groups:

Physics  
Chemistry  
Mathematics

Biology  
Zoology  
Botany

apply now for the BSc (Hons) degree in Biophysical Science (CNAAs). A broad based course in modern biology for the career biologist.

Write or 'phone for further details and an application form to: The Course Tutor, Biophysical Science, North East London Polytechnic, Ref BJ.189 Romford Road, London, E15 4LZ. Tel: 01-555 0811. Ext. 42.

**NELP** North East  
London  
Polytechnic

## THE UNIVERSITY OF AUSTON IN BIRMINGHAM DEPARTMENT OF CHEMISTRY

### MSc Course in the Chemistry and Technology of Polymers.

A vacancy exists on the above course for which a studentship is available. The course will commence on 29th September, 1975 and be of one year's duration. Applicants should possess an Honours Degree in Chemistry, Chemical Engineering or Joint Honours which includes Chemistry.

Further details available from: Mr. A. J. Lovett, Department of Chemistry, The University of Aston in Birmingham, Gosta Green, Birmingham, B4 7ET. Telephone: 021-359-3611 ext 522.

## CHEMIST

with Ph.D. (Sept. '75) and experience in most analytical techniques seeks suitable employment. Keen on R&D. Box No D785.

## GRADUATE (27)

in Zoology/Psychology with MSc. (Zoology) and technical research experience seeks appropriate post. Box No D786

## BOOKS AND PUBLICATIONS

### READ SATELLITE NEWS

every week: subs. £3 per year, sample 10p. G. Falworth, 12 Barn Croft, Preston PR1 0SX.

## PERSONAL

### Computer Dating

For free questionnaire and brochure write to: Dateline (NS), 23 Abingdon Road, London W.8. 01-937 0102

**Dateline**

### 16mm FILM

Professional editing and consultation can gain wider use of existing material. Lucid commentaries written and recorded. Foreign language versions and all post production services. Fees, on time/cost basis, suit meagre budgets. BERR, 22 Redington Road, London NW3 7RG 01-794 2535.

### EXPORTING

to Holland, Belgium, Germany? Interpatch has vans going there frequently, up to 1000 cu.ft. Tel: Stoke Ferry (056 63) 466.

### TWO W. HIGHLAND COTTAGES

Beautiful, remote situation. From £10 per week. Keay, Succoth, Dalmally (Tel 250), Argyll.

New Scientist is printed in Great Britain by Index Printers, Oldhill, London Road, Dunstable, Beds., and Thomas Jenkins (Printers) Ltd, 108 Weston Street, London SE1 and published by IPC Magazines Ltd, 128 Long Acre, London WC2E 9QH. Publishers' annual subscription rates: Ireland £15.10; USA and Canada (airfreight) \$44.30; other overseas £16.40. Sole Agents for Australia and New Zealand, Gordon & Gotch (A'sie) Ltd. For South Africa: Control News Agency Ltd. Conditions of sale: this periodical shall be sold, without the written consent of the publishers first given, be lent, resold, hired out or otherwise disposed of by way of trade at more than the recommended selling price shown on the cover (selling price in Eire subject to VAT) and it shall not be lent, resold or hired out or otherwise disposed of in a mutilated condition or in any unauthorised cover by way of trade or annexed to or as part of any publication or advertising, literary or pictorial matter whatsoever.

# Ariadne

Like murder, radioactivity will out. Useless those carefully regulated hot cells; void the meticulous geological surveys to find safe burial grounds for hot wastes; a travesty the clever encapsulation of spent fuels into glass coffins; pointless those dosimetry badges atomic workers wear day in and day out. For a report in the current *Health Physics* now tells us of rabbits which eat the stuff—and of rabbit predators which eat them—and . . . In short, it is the tale of DDT all over again. At the US Hanford Atomic Works burrowing fauna started the rot by eating radioactive salt which had been interred 30 ft below ground; they and their predators made hay with the stuff over an area 20 miles wide—though happily not beyond the area closed to the public. I feel there must be a moral in the tale somewhere. Does radioactivity merit the status of sin? Or is it simply another facet of the second law of thermodynamics, a phenomenon with a tendency to increasing disorder which ultimately defies man's efforts at control?

Red anything has obviously become bad in official American circles. Like the well known adrenalin stimulant "red horde", the term "red tide" evidently makes washpish hackles rise. For to combat (sic) the subversive dinoflagellate that kills fish and poisons people's oysters NASA and the Florida Department of Natural Resources are to mount a full-scale "early warning system", calling on such cold-war tactics as U-2 aircraft and electronic snooping by NASA's LANDSAT spacecraft. Results from air- and space-borne colour sensors will be corroborated by water clarity tests carried out on the research vessel *Herman Cortez*, ominously described as a "surface truth ship" (Oh, maritime conquistador, what dire microbial instruments of inquisitorial ingenuity lurk beneath your decks?). And the incentive for all this activity? Why, appropriately enough, the good old defence of capitalist activities. In 1971 Florida lost over \$20 million in tourist revenues because of the filthy red tide.

Mnemonics—some of them nightmarishly complex—continue to trickle in in response to that plea in the letter columns. One of the most popular seems to be "George Brown is a live wire." Surely there must be a better way to sort out wires than by a code that requires mnemonics. Mr Jim Smith of 41 King Charles Road, Halesowen, would like to start a mnemonic society. The idea, as he envisages it, would be "to produce mnemonics for all areas of knowledge, starting with school-level data and formulae and working up to more advanced material of degree level." He thinks people would find it fun to compose them. He may be right. The OED traces mnemonics to 1721 but they came into their own in the 1840s. A sample, dredged from a colleague's memory, has the vintage flavour:

## On Old Olympus' Towering Top

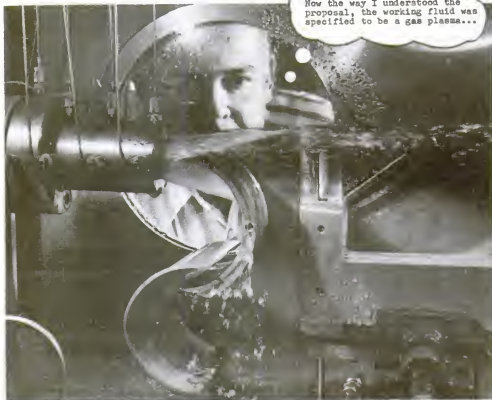
A Finn And German Viewed A Hop

In that case the initials are those of the cranial nerves of vertebrates. Sometimes teachers invent their own. "Help In Learning These Little Molecules Proves Truly Valuable", for instance, was used to memorise the essential amino acids. A chemistry master impressed his classes with the claim that he knew swear words with the initial of every element in the periodic table, then numbering 98.

Quotes new and old: "The belief that science . . . starts from observation . . . is turning out to be a passing heresy. We are rapidly reverting to the older pattern of faith maintained by the educational system and clearly described in AD1370 in *The Vision of Piers Plowman*"—Ronald Stansfield (City University) at the recent BA meeting. "As long as they don't invent phonographic theatres, with all the good actors of an entire season thrown into the purchase of a fireside instrument, it does not much matter."—J. L. Toole, Victorian Actor (*Reminiscences*, 1889).

Last week my chameleactive friend Daedalus devised his mutable dye, which took up any colour it was exposed to if simultaneously irradiated by a particular ultraviolet wavelength. He now proposes a further development of this wonder-concept—the reversible mutable dye. The original invention worked by selective photochemical bleaching of the red, green or blue dyes in the mixture; the

bleached components were "fixed" by reaction with the uv-irradiation products of a fixing chemical in the mixture. Daedalus now reckons that the bleached dyes themselves must be sensitive to some second uv wavelength which will selectively split off the fixing molecular fragments again; these would recombine to regenerate the fixer. The three dyes would be reformed and the mixture would revert from whatever colour it had been back to primal black, ready to take up a fresh colour. This master-stroke of photochemistry, when perfected by the DREADCO team assigned to realising Daedalus's colourful schemes, will open up vast possibilities. Anything coloured by the new "Dreadye" (Regd.) could not merely take up any colour or pattern projected onto it at its owner's whim; it could be changed as often as desired. Clothing would gain a new flexibility. That hated interviews-and-funerals dark suit in the back of every man's wardrobe could be revitalised in between by projecting bolder colours or even riotous patterns temporarily upon it. The detection-rate of motoring offences would plummet as the guilty kept changing the colour of their vehicles to confuse witnesses, and the army's standard drab gear could be irradially recamouflaged to suit local conditions or imitate the opposition. Chalk would vanish from education as instantly erasable Dreadyed blackboards, written on by light+uv beam, took over the classrooms, and bill-sticking and wallpapering would become lost arts as sequences of advertisements or patterns were successively emblazoned on Dreadyed surfaces by projector. Conversely, defacers and graffiti artists, with rival equipment of their own, would find a new freedom in projective embellishment from a safe distance.



## It's 3.30pm in Brussels and you've got to meet your chairman in Rome for dinner.

As the crow flies.

Next direct flight leaves 7.15pm.

Arrives Rome 11.25pm.

As Swissair flies.

Next Swissair flight via Geneva

leaves 3.50pm. Arrives

Rome 8.35pm.



Time saved: 2 hours 50 minutes.

## It's 3.00pm in Paris and you want to be in Vienna as soon as possible.

As the crow flies.

Next direct flight leaves

8.45pm. Arrives Vienna

10.30pm.

As Swissair flies.

Next Swissair flight via Zurich

leaves 4.20pm. Arrives

Vienna 7.55pm.



Time saved: 2 hours 35 minutes.

## It's 4.30pm in Madrid and you've got to be in Munich that night.

As the crow flies.

Next direct flight leaves 9.55am the

next day. Arrives Munich

12.30pm tomorrow.

As Swissair flies.

Next Swissair flight via Zurich

leaves at 4.50pm today. Arrives

Munich 8.25pm.



Time saved: 16 hours 5 minutes.

Swissair offers connecting flights between 37 European business centres.



SWISSAIR: BECAUSE WE'RE CLOSER TO MORE BUSINESS CENTRES IN EUROPE THAN ANYONE ELSE.

# "Leadership in technology depends more on people than on machines"

From a report  
by Dr M. Appl of the BASF  
Ammonia Department.



Without ammonia synthesis, it would no longer be possible to meet the world's demand for fertilizers. This method of producing ammonia on an industrial scale was first developed by BASF. In the last twenty years, it has undergone hectic growth, which is of enormous significance for the



world's food supply. Such progress would never have been possible without the development of high-pressure techniques, a field which BASF have pioneered from the very beginning. BASF's high-pressure techniques also played an essential part in many other major processes

requiring pressures as high as 3200 bar (atmos.). Today, the demands imposed by the need to optimise energy consumption and preserve complete safety are even more severe. It is to these aspects that BASF process engineering is devoting its attention at present.

In the field of advanced technology there is only one way to keep ahead: by employing the best brains.

Brains are people; and BASF have achieved their position as leaders in the chemical industry by treating people as first in importance. As a result, BASF now employ over 10,000 people in research, many of them distinguished scholars in their fields.

BASF put people first. Not only people at the frontiers of technology but the people who buy and use BASF products. People in industry who use our dyes and printing inks and dispersions, adhesives and plastics and intermediates. And you, the people whose lives are touched and affected by BASF products at every point. Human benefit is the criterion by which all the research, the technology, and the products are finally judged.

There is a brochure that tells you all about BASF.  
Write for your copy to the people concerned  
BASF United Kingdom Ltd. P.O. Box 4, Earl Rd.,  
Cheadle Hulme, Cheadle, Cheshire SK8 6QG.

Name \_\_\_\_\_ Company \_\_\_\_\_  
Address \_\_\_\_\_

## BASF are the people concerned

# BASF